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"FLASHING" FILAMENTS.

THE weight of common sense seems to be on the side of the judgment delivered last Saturday by the Court of Appeal in the suit between the owners of the patent taken out in 1878 by Mr. Cheesbrough (for Messrs. Sawyer and Man) and Messrs. Woodhouse and Rawson. The patent mentioned was for the process of preparing carbon filaments for use in incandescence lamps known to our readers as the flashing process, and also for the material resulting from the execution of that process. The defendants in the action were alleged to have infringed the patent both by exercising the process and by using the material. That their process and resultant carbon filament were identical with those of Sawyer and Man the defendants did not positively deny, but justified themselves by pleading that a precisely similar carbon filament had been produced before the date of the patent, which was therefore not valid, and further that the patent could not be sustained because its language was ambiguous and misleading. Certain experiments by Despretz, a famous French chemist, were the principal anticipation cited. Despretz was seeking a totally different object from that which Messrs. Sawyer and Man had in view, and although he produced, to his own disappointment, a result which was to some extent similar to their result, there was no evidence, the Court held, that the carbon he obtained possessed all the essential characteristics of the carbon described by the patentees as obtainable by their method of preparation. No one seems ever to have attempted to produce a carbon by Despretz's process, so that there could be no actual test as to the suitability of such a carbon for the purposes of an incandescence lamp; but the judges gave their opinion that the process was not one by which a non-porous carbon could be produced, although there might be a superficial deposit upon the carbon of graphite in all respects similar to that obtained by the plaintiffs. In their words, "by following Despretz's process, carbon resulting from the decomposition of carburetted hydrogen is deposited over the whole apparatus, and is wasted; whereas by following the plaintiffs' process the carbon is deposited where it is wanted and utilised." This, of course, set at rest all question as to the suitability of Despretz's material for the purposes for which the plaintiffs' carbon was designed, and it became unnecessary for the Court to decide a very interesting point of law which was raised, namely, assuming that what Despretz produced was similar in all respects to what was produced by Sawyer and Man, whether an experiment such as Despretz's, which had no reference to electric lighting, and a material such as Despretz's, the suitability of which for electric lighting was never pointed out, could constitute a sufficient anticipation to render a subsequent patent void for want of novelty. The second and only other anticipation depended upon was an experiment by Sidot, another French chemist, but this was dismissed by the Court in very few words. Sidot operated on his carbon by the application of heat externally, and the process therefore was totally different from that of the patentee; moreover, his material was less dense than, and generally inferior to, the material produced by means of the patentee's process. The only remaining defence was as to the ambiguity of the specification and its misleading character. Applying strict rules of definition, it may be allowed that the language in one or two instances was scarcely as careful and accurate as it might have been. Beeswax, balsam, and oils may not, in the strictly scientific sense, be hydro-carbons; they contain hydrogen and carbon, but not those elements only, as hydro-carbons, accurately described, should. Bringing common-sense and reason to bear upon the construction of the specification, however, it must be conceded that "the competent workman" would have no difficulty in comprehending what was meant by the patentee or in producing the material described; and that, as has over and over again been held by the Courts, is all that is necessary to uphold a specification against the allegation of want of clearness.

THE ELECTRIC LIGHTING ACT.

LORD THURLOW has, in his new Bill for the amendment of the Electric Lighting Act (1882), introduced in the House of Lords last week, accepted the principle of according to local authorities the power of compulsory purchase in regard to electric light undertakings, but only with the important proviso that the goodwill of the business shall be taken into account, and the market value of all lands, buildings, works, materials and plant be paid. The Bill also stipulates for the extension of the period after the expiration of which the local authority may exercise its power of acquisition from 21 to 42 years. These provisions, of course, take the sting out of the much execrated 27th Section of the Act, and, all attempts in the past to procure the total repeal of that section having failed, those engaged in electrical work will probably support Lord Thurlow's Bill as being the most satisfactory solution of the legislative difficulty they are likely to obtain. Besides thus amending the compulsory purchase clause, the Bill provides for the protection of the Postal Telegraph lines from interference, and also contains a clause by which the Board of Trade may vary the terms upon which any local authority may require the undertakers to sell "in such manner as may have been agreed upon between such local authority and the undertakers." Objections to this clause, which was included in one of the Bills of last year, were pointed out in the REVIEW of June 18th, 1886; but, of course, under the altered conditions proposed, those objections have not the force which they then possessed.

UNDERGROUND versus AERIAL TELEGRAPH LINES.

(*Continued from page* 133.)

ALTHOUGH the prime cost of underground wires is much in excess of that of overhead work, yet inasmuch as the cost of maintenance is very considerably less, the capital sum represented by the annual saving would probably far more than cover the extra initial outlay, and, therefore, were there not other important points to be considered, the general adoption of an underground system would probably prove a financial success. As a matter of fact, however, there are very important points which materially modify the first aspect of cost. A great deal has been said by the general public on the whole question, more especially with reference to the system of subterranean lines which have been laid down in Germany. An underground system has been adopted in Germany, it is urged, which works satisfactorily; obviously, therefore, it is argued, a like system could be adopted in England. Now, anyone who is acquainted with both the German and English systems of telegraphic communication will see that a very considerable difference exists between the two. Celerity of transmission as regards Germany is not thought of and probably is not required. The staff of clerks employed to work the telegraph apparatus are, we believe, largely composed of old army men, who, although they do the work required with the necessary efficiency, are not remarkable as quick senders. Duplex working is practically unheard of in Germany (a fact which does not seem to be generally known), chiefly because the class of operators employed are, through various circumstances incident to the military system in force, not able to attain the technical skill necessary to keep the apparatus in working order. Slow working is, therefore, the rule rather than the exception, and it is such working only that would be suitable for long underground lines. When we consider that a speed of about 35 words a minute is probably the rate at which the ordinary hand-working can be carried on through the long underground wires, and that at the present time by means of the Delany multiplex system, a single aerial wire can have its ordinary working capacity quadrupled, or by means of the Wheatstone automatic instrument can enable a speed of 450 words per minute to be attained, it must be obvious that the general adoption of an entire underground system in England is out of the question, more particularly in view of the continually increasing traffic which more and more renders high-speed working a necessity. The extent to which the substitution of underground for aerial wires reduces the speed of working will be seen when it is mentioned that speed varies inversely as the static capacity of a wire. Now, the best result as regards low static capacity in covered wire of the size which has hitherto been most generally adopted in this country, viz., No. 18 copper covered to No. 7½ gutta percha is about ·230 microfarads per mile. In cables of the Berthoud-Borel type this result has been considerably reduced, but still the results are very far indeed from approaching to those obtained with an aerial wire, whose static capacity per mile is as low as ·0135 microfarads. No system of underground work that can be devised is likely to be able to approach in value, as regards low static capacity, to an overhead wire. The latter has practically only its lower circumference forming a condenser surface, the thickness of the dielectric is, as a rule, as much as 20 feet, and the specific capacity of air is lower than any solid substance. In the case of an underground wire we have the whole circumference subject to inductive action, the dielectric must be comparatively thin, and being solid (or liquid) would have a less specific value than air. It seems improbable that a wire in any underground system can be made to have a less static capacity than about ten times that of an aerial line having a conducter of similar diameter; this means that the utmost working capacity for transmitting signals at a high speed is ten times less.

(*To be continued.*)

FRENCH POSTAL DEPARTMENT.

WE gather from the report which appears in the *Journal Officiel* on the discussion by the Chamber of Deputies of the Telegraph and Postal Budget for 1887, that the postal circulation in France has, during the last six years, increased 76 per cent., and during the same period the telegraph business has been augmented 198 per cent.

The following table gives a comparison of the business transacted in the postal department in France, Germany and England.

	France.	Germany.	England.
Number of letters	524 millions	778 millions	1,322 millions
Number of post cards	33¼ „	225½ „	154 „
Number of newspapers	359¼ „	532⅓ „	427 „
Number of post-offices	6,819	15,428	16,434
Postage per letter (centimes)	0·15	0·12	0·10
Postal maritime annual subventions (francs)	26 millions	Less than France or England.	18 millions
Estimated postal receipts for 1887 (francs)...	29¼ „	35¾ millions	55 „

During the discussion it was stated that in France there is not a single hamlet or village, however small, indeed not a single house, which is not visited by a postman; whereas in England there are 400 hamlets completely severed from direct postal communication. It was also pointed out that while every one of the French post offices is completely organised for the execution of all postal work, in England only half of the offices are thus habilitated. The excess of receipts over expenditure was stated to be, in England as 40 per cent., in France 21 per cent., in Germany and Italy considerably less; while in the United States there is an excess of expenditure over receipts of 9 per cent. Attention was drawn to the fact that while the 26 million francs paid for maritime postal subventions is in France charged against the Postal Department, in England these subventions are charged against and paid by the Admiralty. It was also shown that the officers and troops despatched abroad are carried by the French subventioned lines free of charge to the Government, whereas in England the Government has to pay, in addition to any subvention, for all such transport.

TELEGRAPHIC COMMUNICATION BETWEEN FRANCE AND HER COLONIES.

IN the debate on the Budget for 1887, a deputy, M. Roulleaux-Dugage insisted on the necessity which existed for a more direct telegraphic communication between France and her colonies. He called attention to the manner in which England had thrown a network of submarine cables over the whole world, and had virtually monopolised this medium of communication. In the course of his speech he pointed out that France possessed direct communication with only one of her distant colonies—St. Pierre and Miquelon, by the Pouyer-Quertier cable.

In the West Indies communication with the islands of Martinique, Guadaloupe and dependencies is held *via* the lines uniting Demerara with Jamaica and Cuba, and which are owned by two English companies, the West India and Panama Telegraph Company and the Cuba Submarine Telegraph Company.

French Guiana, which at one time was connected with Demerara, is now cut off from telegraphic intercourse, the cable which once existed between these places having been allowed to perish. The only line which could now give telegraphic communication to

this colony is the cable of the Western Brazilian Telegraph Company. This again is an English enterprise.

The French possessions on the West Coast of Africa at St. Louis, Dakar, Konakri, Porto Novo, Grand Bassam and Gabon, depend for communication with France on the West African Telegraph Company and the Spanish National Submarine Telegraph Company. These are also English companies.

Mayotte, Nossi Bé, Diego Suarez, and the French possessions in Madagascar, have not as yet been connected up, but the easiest manner of bringing the telegraph within their reach would be *via* Mozambique and Zanzibar, where English companies—the Eastern Telegraph Company and the South African Telegraph Company—again hold possession.

Passing to the French possessions in India, it is seen that the colonies of Pondicherry, Karikal, Mahé, Chandernagor and Yanaon, can only communicate with Europe by the Indian Government land lines and the cables of the English Eastern Telegraph Company. Going further North, English telegraph companies extend their operations to Shanghai. Northwards beyond this point, an English company has absorbed the original Danish telegraph company.

The French possession of New Caledonia and its dependencies have as yet no telegraphic communication, and can only obtain this *via* New Zealand and Australia, where yet another English company—the Eastern Extension Telegraph Company—is met with. Tonkin and Annam are also served by English telegraph companies.

Coming back to the Mediterranean, the French Government possesses three cables between Algiers and Marseilles, but they were made and laid by an English company.

The speaker then pointed out the difference which existed between France and England as regards the manufacture of submarine cables, the secondary place France had to occupy in consequence, and the great expense the country was put to in subsidising foreign enterprise. In England there are several rich and powerful cable manufacturing companies, owning a considerable fleet of large ships built for the express purpose of submarine cable work. France possesses the small works at La Seyne (Toulon), and owns two almost prehistoric cable ships, the *Charente* and the *Ampere*, of small size. The works at La Seyne are only fit to re-sheath short pieces of cable, and the ships have a capacity of only 1,000 tons each.

Here a rather lively passage of arms took place between the speaker and M. Cochery, the latter coming off but second best in the encounter, which originated in M. Cochery asserting that the deputy was not correct in his statement regarding the works at La Seyne. M. Roulleaux-Dugage concluded by insisting that France should follow the lead taken by Italy, and provide herself with submarine cable factories of sufficient importance to render her independent of English manufacturers.

In reply, the Minister of Posts and Telegraphs stated that before long he hoped to show that the Government had taken the matter into serious consideration.

THE BELL TELEPHONE SUITS.

ON the 24th day of January the hearing of the appeals in the five telephone suits before the Supreme Court of the United States began. From the bench of judges, Justice Woods and Justice Gray were absent. The former was ill, and the latter decided not to sit in judgment on the case, because his relatives held Bell telephone stock. The five cases are appeals by the following parties from decisions of the circuit courts:—1, Amos G. Dolbear; 2, the Molecular Telephone Company; 3, the Clay Commercial Telephone Company; 4, the People's Telephone Company; 5, the Overland Telephone Company. The Court assigned a period of two weeks to the hearing, which is now going on from day to day.

Much sensation was created at the outset by Mr. Lysander Hill's charges in his brief and argument, relative to alleged collusion between Bell's attorneys and the Patent Office Examiner. He charged that the original copy of the patent with erasures marked upon it had been withdrawn from the Patent Office, and a clean copy substituted. This charge was met by Mr. Storrow of counsel for the Bell Company, who stated that the change of specifications as alleged had never been made; but that he himself had made some comparative memoranda upon a certified copy of the specification for use in the Dowd case, and that these personal memoranda had been printed in the record in the Dowd case, and this was assumed by Mr. Hill to be a true copy of the original Bell specification, while it really had nothing to do with it. This was generally regarded as a point scored by the Bell Company. Mr. Lysander Hill appears for the Drawbaugh Company, the People's Telephone Company.

The immense size of the records before the Court, and the magnitude of the interests involved in the decision, will render this one of the memorable law trials. The Bell Company is said to have already spent a million of dollars in litigation, and the value of their franchise, as indicated by dividends and outside interests, is probably worth over one hundred millions of dollars. The Court has before it twenty volumes of records, embracing 15,000 pages, besides the voluminous briefs of the different counsel.

The fact that five cases are to be jointly tried, and that such full records of testimony are produced, would seem to point to a thorough sifting of the rights of the parties and of the true scope of the claims of the Bell patent. But unfortunately this thoroughness is only apparent. All the cases are burdened by concessions and weakened by omissions. The full case against Bell, it is to be feared, will not be presented.

The Supreme Court is rigorously confined in its judgments to the case as presented by the proofs taken in the lower court. It has no right to take or call for any new proofs. Its work is really a revision of the circuit courts' judgments. In recent times there has been a pronounced tendency on the part of the Supreme Court to decide against monopolies. Its memorable reissue decisions have done much to limit the scope of patents. Formerly, it was a frequent practice to reissue a patent before beginning a suit, thereby putting its claims and specification in condition for the specific suit to be brought. The Supreme Court has, by the decisions alluded to, put a stop to this practice. Each patent that comes before it must stand on its original claims. This alone has made many patents valueless. The court has also been much more vigorous in its treatment of patents than were the old school of judges. Its reputation now is that of a destroyer rather than of a sustainer of patents. Many a patent runs the gauntlet of the circuit courts successfully, to be pronounced invalid on appeal. Within late years, it has been impossible to withstand, with the least prospect of success, the Bell Company in the circuit courts, owing to previous favourable decisions. Whatever the issue, the merits are now to be judged by a tribunal whose tendency is opposed to patents, and which is unfettered by previous decisions.

A very interesting point is the bearing of the House telephone on these suits. No such complete defence against the Bell claims has yet been produced. First in the columns of this, and later in those of other papers, it has been described and illustrated. Yet the Supreme Court can make no use of it in framing an opinion, because it is not in the circuit court records. If the judges know of it, and they probably do, their position is a peculiar one. They may be convinced that it should break the Bell patent, or at least greatly abridge the claims, yet they can take no cognisance of it in rendering their decision. It is quite within their power to allude to it in their opinion, merely as a matter of history; but for them it is not evidence.

This is greatly to be deplored. The best and most conclusive defence yet produced is excluded from con-

sideration. The court may find itself in the position of a judge who, following the verdict of a jury which has pronounced a man guilty, condemns him to punishment, knowing him to be innocent. This hypothetical case is one often cited by moralists.

On February 4th the time set for the hearing expires. The opinion and decision will then be anxiously awaited. It is earnestly to be hoped that some limitation may be placed upon the extravagant claims of the Bell Company. Meanwhile, the Government suit for the cancellation of the Bell patent is progressing in Massachusetts. In this the House telephone will probably figure as a most important reference. But the remedy, if this shall prove the only one, comes at a late day. Already two-thirds of the period of the patent has nearly expired, and in 1893 the first Bell patent will be public property.—*Sc. Am.*

THE SO-CALLED "DEAD WIRE" OF THE ARMATURES OF DYNAMO MACHINES.

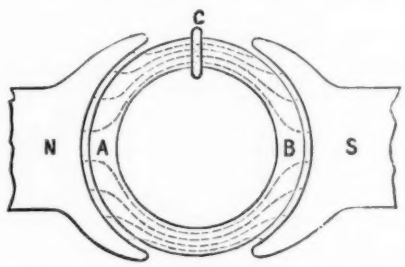
IT is almost universally taught that that portion of the wire of an armature that does not traverse the field of force, that is, does not cut across the force lines, is "dead wire," and that it should be the aim in designing a dynamo to reduce the amount of it as much as possible. The inside wire of the Gramme ring, for instance, is often referred to as so much waste resistance. The wire that crosses the ends of the Siemens armature is considered in the same light. It has been attempted to improve the Gramme machine by placing pole pieces inside the armature, and we have been taught, on what should be good authority, that the Siemens armature should be of considerable length in proportion to its diameter, though this for other reasons should not be carried to extremes.

But this whole subject, says Prof. W. A. Anthony in the New York *Electrical Engineer*, may be viewed from another standpoint, which may cause it to appear in a different light. In all machines except those of the Faraday disc and the Siemens unipolar types, the moving wire encloses an area through which the lines of force of the field are alternately taken and excluded as the coils revolve. It is demonstrated in all the text books by the familiar assumption of a straight wire sliding across a uniform magnetic field on two fixed parallel rails, which are joined together by a fixed wire at some distant point, so that the whole forms a closed circuit, that the E.M.F. in the moving wire is equal to the area swept through per second multiplied by the intensity of the magnetic field, and, since the intensity of the field is conventionally represented by the number of lines passing through unit area, the E.M.F. in a closed circuit due to motion in a magnetic field, is equal to the number of lines of force taken into or excluded from the circuit per second.

In the Siemens unipolar dynamo, where a conductor moves across the lines radiating from the poles of a magnet, the area enclosed by the circuit is not altered, and the E.M.F. is equal to the number of lines cut per second by the moving conductor. But here only the E.M.F. due to the one length of conductor can be obtained, except by the use of a complicated system of sliding surfaces. In all practical dynamos the moving wire forms a coil, and the E.M.F. developed by its motion is determined by the rate at which lines of force are taken into or excluded from the area enclosed.

Consider the Gramme armature:

Let A, B, be the iron core, N and S the pole pieces. C one of the coils of wire. Lines of force pass from the pole piece, N, into the ring, and, following around it, pass out into the pole piece, S. These lines pass through the coil, C, in the position represented, but, as the armature revolves, when C reaches the position B, all the lines have been excluded. Following C through one revolution, it will be seen that all the lines of force are twice included and twice excluded, and if n = the number of revolutions per second, $4\ n\ N$ is the number of lines per second swept through by the coil, where N is the maximum number of lines passing through it; and $4\ n\ N$ is, therefore, the average E.M.F. developed by that coil. To increase the E.M.F. without increasing the speed of rotation, the number, N, of lines which it includes and excludes must be increased. It is immaterial how they are introduced or discarded, whether by the outer or inner portion or by the edges, and the theory that makes all the wire except that outside the iron ring "dead wire," assumes that the number of lines of force that follow the ring from pole to pole is proportional to the area exposed to the pole pieces, and would be doubled or at least largely increased by presenting pole pieces to the inner surface of the ring. Whether this is probable can be best understood by considering the whole magnetic system of the machine as a *magnetic circuit* in which lines of force are developed by the field magnet coils according to a law similar to that of Ohm for electric circuits. According to this view, iron is the best of all conductors of magnetic lines, but air is by no means an insulator; and in a thick layer of considerable area, as in the space between the pole and iron ring in the figure, the resistance it offers may be small as compared with the iron in other parts of the circuit. The ring itself has a comparatively small cross-section, and moreover the resistance of iron increases greatly with the number of lines of force it has to carry. It may



happen that the resistance of the air space between the pole and armature ring shall be less than that of the ring itself. It this be so it would avail little to increase the surface presented to the ring by adding an interior pole piece. Its effect could only be to diminish a resistance that was before only a small fraction of the whole, and the number of lines of force passing through the coils would be only very slightly increased.

Now consider the Siemens armature. To fix the ideas take a particular case. Suppose the mean length of the armature 18 inches, and mean diameter 6 inches. The length of one turn of wire is 48 inches and the area enclosed 108 inches. An armature 12 inches long and 12 inches diameter would require the same length of wire, but each turn would enclose an area of 144 square inches, and supposing the strength of field the same, the coils in the latter case enclose one-third more magnetic lines than in the former. But how would this change of dimensions affect the field? There need be no change in the field magnets. The pole pieces would be changed in form, but the area presented to the armature is not changed. The cross-section of the armature core is the same in both cases. In the 12×12 armature the distance through the core from pole to pole is greater, but since its circumference is twice as great, the wire will occupy only half the depth, and the air space between the poles and core will be much less. It is safe to assume that the total resistance of the magnetic circuit for the 12×12 armature would be less than for the 6×18, and that the number of lines of force passing through one of the coils of the former would not be less than one and-a-half times the number passing through the latter. The larger armature, therefore, would need to make only two-thirds as many revolutions per minute to develop the same E.M.F. It would appear, therefore, that *other things being equal*, the best form of coil for an armature would be the form that enclosed the greatest

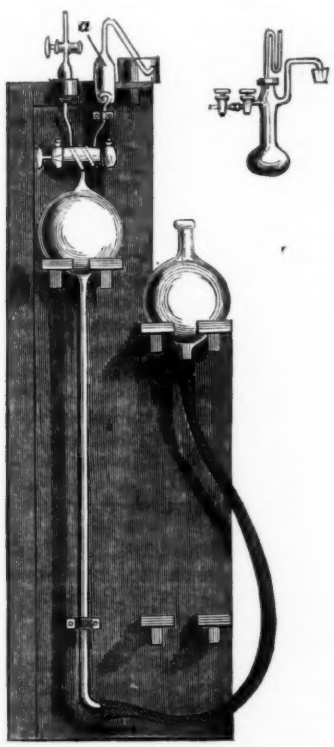
area, with least electrical resistance, that is the circle; such are the coils of the spherical armatures of Thomson and Houston.

It must, however, be remembered that there are three factors determining the E.M.F. of a given machine; armature area, revolutions per minute, and strength of field. These are not wholly independent of each other. The form of armature in itself the best, might not permit the best form of field or the highest speed. The three factors must be considered together, and such a form adopted as will on the whole give the best results.

It must not be inferred from the above, that there is any error in the view that ascribes the E.M.F. of an armature to the cutting of the lines of force of the field by a portion of the wire, while another portion is inactive or "dead." Both methods of viewing the subject are correct, and will lead to the same results if all the factors that enter into the problem are considered. The error lies in the supposition that the dead wire may be brought to life and made to add to the E.M.F. previously existing, by merely presenting to it the pole of a magnet. If those who have expected great things from the pole inside the Gramme armature, had looked at the problem from the point of view of the number of lines that pass through the armature coils, might it not have suggested the question whether the added pole piece would increase that number, or lessen the lines from the outside pole piece by just the number furnished from within?

A NEW MERCURY PUMP.

THE mercury pumps now in use, whether those of Geissler, Alvergniat, Tœpler, or Sprengel, although possessed of considerable advantages, have also serious defects. For instance, Geissler's pump requires a considerable number of taps, that of Alvergniat and Tœpler is very fragile in consequence of its complicated system of tubes connected together, and that of Sprengel is only suitable for certain purposes.



The new mercury pump constructed by Messrs. Greisser and Friedrichs, at Stützerbach, is remarkable for simplicity of construction and for the ease with which it is manipulated, and also because it enables us to arrive at a perfect vacuum.

The characteristic of this pump is, according to *La Lumiere Electrique*, a tap of peculiar construction. It has two tubes placed obliquely in respect to its axis, which, when we turn this tap 90 or 180 degrees, are brought opposite one of the three openings in the body of the tap.

Thus the striæ that are formed between the hollowed-out parts of the tap do not affect its tightness; and, besides, the turns of the tap have for their principal positions 90 and 180 degrees, instead of 45 and 90 degrees, as in Geissler's pump.

The working of the apparatus, which only requires the manipulation of a single tap, is very simple. When the mercury is raised, the tap is turned in such a manner that the surplus of the liquid can pass into the enlarged appendage, *a*, placed above the tap, and communication is then cut off by turning the tap to 90 degrees.

The mercury reservoir having descended, the bulb empties itself, and then the tap is turned on again in order to establish communication with the exhausting tube. The tap is then closed, the mercury ascends again, and this action keeps on repeating.

THE CHARACTERISTIC CURVES OF DYNAMOS.*

By L. G. HODGSON, Student, King's College.

PERHAPS the best way to explain the object and uses of these curves is to compare them to the indicator diagrams of steam engines. At the same time there are certain differences between the two, so that the analogy does not altogether hold good. In the first place the indicator diagram compares the pressure and the distance travelled by the piston, and by the area enclosed shows the power expended. Now the characteristic does not of necessity compare the electromotive force and the current. For we may construct characteristics showing the relation between the E.M.F. and the speed of rotation of the armature or comparing the H.P. with the speed.

However, it is the characteristic obtained by plotting the E.M.F. as ordinates and the currents corresponding as abscissæ that is of most general utility, and this it is that most nearly corresponds to the indicator diagram. One more point of difference should be noticed, namely, that the indicator diagram is a closed curve and really corresponds only to a single point on the characteristic. For the latter may be said to show the working of the machine at any power between its utmost limits and not at any one point like the indicator diagram.

In the case of a machine in which the excitation of the field magnets is independent of the current generated in the armature it would be natural to expect the characteristic to take the form of a straight line, For in such a case the E.M.F. should vary with the speed at which the machine is driven, and for a given speed should be constant.

What really happens is that the current flowing in the armature causes alterations in the resultant field, and so as the current increases in magnitude the E.M.F. decreases. In such machines, then, the difference of the ordinates of the curve found experimentally from those of the theoretical straight line is a measure of these disturbing and prejudicial reactions.

In what are known as self-exciting machines the field magnets are excited by the whole or part of the current being made to flow through the coils on them. Up to a certain point, depending on the shape and size of the iron cores and on the nature of the iron used,

* Read before the King's College Engineering Society, January 25th, 1887.

the intensity of the magnetism evoked varies directly as the magnetising current. But after a certain point is reached the iron begins to get saturated.

In any machine, whether self-excited or separately excited, the E.M.F. generated is a function of the magnetic intensity of the field when the speed and length of wire on the armature are constant. Therefore in the case of a series machine, if, as before, we plot the volts and ampères we shall get for the first part of the characteristic a straight line. In a shunt machine the magnetising current is dependent both on R_s and R, where R_s is the resistance of the shunt and R that of the external circuit, and the above does not obtain. Before, however, discussing the distinctive features of the curves obtained from the various types of machine it will be best to explain how these curves may be constructed.

In the first place these curves may be divided into two classes, to which it is general to give the distinguishing names of internal or total and external characteristic. The first class considers the whole E.M.F. generated in the machine, including that spent in overcoming the internal resistance. The second class deals only with the output as measured at the terminals of the machine. To obtain the first it is necessary to know the whole resistance in the circuit, including the machine itself. Then if the current be measured by some

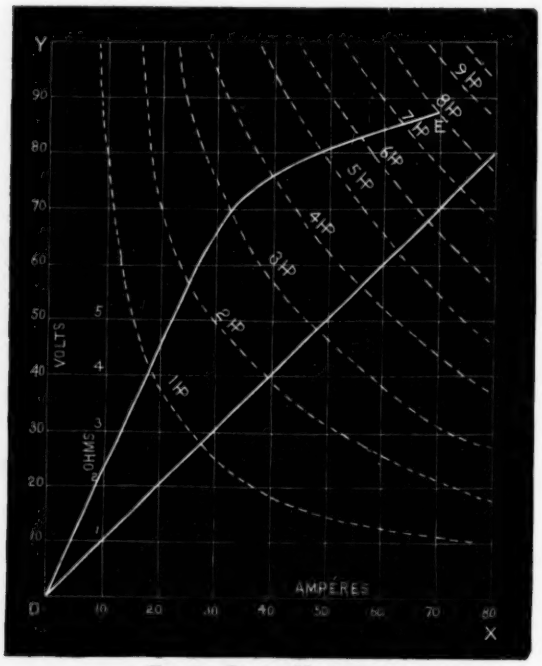


FIG. 1.—SERIES MACHINE.

suitable instrument the E.M.F. can be easily calculated by Ohm's law. In the second case it is sufficient to measure the difference of potential at the terminals with a voltmeter and, at the same time, the current with an ammeter.

A sufficient number of readings having been taken the corresponding values of the E.M.F. and current should be plotted to the same vertical and horizontal scale. If this is not done the curve will be distorted and may either make the performance of the machine appear worse or better than it really is.

If a set of rectangular hyperbolas having the axes as asymptotes are drawn on the diagram, so that one passes through all points where $x\,y = 746$ and another through all points where $x\,y = 2 \times 746$, and so on; the electrical H.P. given by the machine may be read at a glance.

It is also possible to represent resistances graphically on these diagrams. For at any point on the characteristic the resistance in circuit $= \frac{\text{volts}}{\text{ampères}}$, or say $= \frac{y}{x}$, that is to the tangent of the angle which the line joining that point to the origin makes with the axis of X.

Suppose we have a series machine with the armature revolving at a given speed, and the circuit open. Under these circumstances the only induction taking place in the armature will be that due to the residual magnetism in the fields. Consequently the characteristic should start from the axis of y a short distance above the origin. Now suppose the circuit closed at first with a considerable resistance, then a small current will traverse the exciting coils of the fields and will cause the E.M.F. to rise. As the resistance is diminished, and the current increases, the E.M.F. will continue to rise and the characteristic will be, approximately, a straight line.

When, however, the current has increased to a certain point the iron in the field magnets will begin to be saturated, and consequently the E.M.F. will not rise in the same proportion to the exciting current as it did at first. Consequently the characteristic will gradually become more horizontal, though if all other reactions were eliminated it would never actually become horizontal, owing to the inductive effect of the F.M. coils themselves. However, this is never actually the case, for when the current traversing the armature becomes very large, or at any rate larger than that for which the machine was designed, various detrimental reactions take place in the armature, self-induction effects for instance, which increase the apparent resistance of the armature and cause a falling off in the E.M.F. So that the curve actually does become horizontal, and in many cases comes to be inclined in an opposite direction, so as to approach the axis of X.

In some machines this downward curve of the characteristic is very apparent, but it does not necessarily follow that, because the effect of these reactions in the armature is so marked, the machine is badly designed. In fact, these reactions may be made a kind of safeguard against the production of a current so large as to endanger the machine by overheating.

The distinctive form of the characteristic of a shunt machine is very different from that of a series machine, that is to says of its external or terminal characteristic. For in a shunt machine another curve could be drawn comparing the E.M.F. with the current passing through the shunt, and this would practically be the same as that of a series machine. Let us suppose, as before, that our shunt machine is running with the circuit open. In this case the only current generated is that passing round the shunt, and the E.M.F. will be at its maximum. The characteristic, therefore, in this case starts from a point on the axis, Y, at a considerable distance above the origin. Directly the circuit is closed the E.M.F. will fall off more and more rapidly as the resistance is diminished, till the characteristic becomes almost a vertical line for a short distance. After this point the external resistance is so small compared with the resistance of the shunt coils that the current passing the latter is not sufficient to maintain the magnetism of the fields. On account of this the characteristic bends back towards the axis of Y, and becomes a straight line. When the machine is short circuited this line terminates at a point determined by the E.M.F. induced by the residual magnetism and the current which this forces through the resistance of the armature.

It is interesting to compare the typical curves of series and shunt machines.

The first begins with a straight line, but after a time the inclination diminishes, the curve becoming horizontal, and eventually returning towards the axis of X.

The second begins with a straight line, which bends and returns to the axis of Y.

The meaning or interpretation of the bend is different in the two cases. In the first case it shows that the F.Ms. are saturated, or nearly so, by the current in the circuit. This is called the "critical current" of a series dynamo, for until the current has acquired that magnitude the machine will not work at its best. Thus if the resistance exceeds a certain amount a series machine will not work properly unless the speed is increased, though the critical current will always be the same number of ampères.

In the shunt machine the bend in the curve does

not show a critical current, but a critical resistance, and if the machine has less resistance than this in the external circuit there will not be sufficient current in the shunt coils to excite the machine properly. This critical resistance will always be the same in the same machine just as the critical current is the same in a series machine; for it must always bear a given ratio to the resistance of the shunt.

The difference of the two types of the machine is perhaps best illustrated by drawing a curve (fig. 3) for each showing how the potential alters according to the resistance in the external circuit. If we plot volts as ordinates and ohms as abscissæ, we get in the case of a series machine a curve which starts with a maximum number of volts when the resistance is a minimum, and gradually falls as the resistance increases; while with the shunt machine the opposite obtains, for the curve starts from the origin and gradually rises, the number of volts becoming a maximum when the resistance is infinite. These different properties of series and shunt machines are very important, for it is by combining them in a compound wound machine that we get a dynamo which is self-regulating.

Suppose we want a machine to give always a constant difference of potential at the terminals. The characteristic of such a machine should be a perfectly straight horizontal line. The way in which this is obtained is to have a series machine plus some additional excitement of the magnets. Let us consider the total characteristic of such a machine, that is, we will take into account the whole E.M.F. generated in the armature.

The characteristic will start from some point on the axis of Y, the number of volts depending on the supplementary excitation, and from that point will gradually rise, at first as a straight line as in the characteristic of an ordinary series machine.

If, now, below this we draw a line through the origin representing the resistance of the machine itself, we see that for the machine to give a constant difference of potential at the terminals the straight part of the characteristic must be parallel to the line representing the resistance of the machine.

Now the inclination of the characteristic depends on the speed of the machine, and thus a critical speed may be found at which the machine will be self-regulating as long as the iron in the fields does not get saturated; for we know when this occurs that the characteristic of a series machine is no longer a straight line, and so can no longer keep parallel with the line representing the resistance of the machine. It does not matter whether the supplementary excitation is by means of permanent magnets, by coils fed from some other source of electricity, or by shunt coils from the machine itself.

Let us return a moment to the two curves comparing the relation between the E.M.F. and external resistance in a series and shunt machine. The first begins with a certain difference of potential which falls as the resistance increases, while the other begins low and rises as the resistance increases. Suppose these two curves superposed and the ordinates of each added together, we should get an approximately straight horizontal line roughly showing the compensating action of such a combination.

If we take Y to represent the number of volts which our machine is to give, then the excitation due to the shunt coils must be such as to give Y volts when the machine is on open circuit, and the excitation of the series coils must give Y volts when the machine is short circuited, the armature in both cases revolving at the speed it is intended to run at; but of course as no machine is ever intended to work on short circuit, in an experimental determination of the winding, for the latter experiment another would be substituted to find the number of ampère turns required to give Y volts when the external resistance was least; for instance, when the machine was driving its full load of incandescent lamps in parallel. From this the number of ampère turns to be furnished by the shunt and series coils respectively could be determined.

Besides this, the regulation of the dynamo will depend on the coils being so proportioned that the E.M.F. due to the series coils falls off at exactly the same rate as the E.M.F. due to the shunt coils increases when the resistance is increased.

Supposing the machine is to give a constant current, the external characteristic should be a straight vertical line.

The nearest approach to this is given by a shunt dynamo plus some supplementary excitation. The total characteristic must start from a point whose co-ordinates are the potential given by the supplementary excitation and the current sent through the armature, and must be parallel to the line inclined to the axis of X at an angle whose tangent represents the resistance of the machine. In this case the characteristic is so steep that the current in the shunt is unstable, and no satisfactory solution of the difficulty has been arrived at.

The external characteristic of a compound wound machine should be a straight line, and the nearer it approaches one in practice the better is the regulation of the machine.

The curve in the case of such machines is useful in showing within what limits the machine is self-regulating.

In the case of a series machine running some arc lamps, which necessitates the E.M.F. being kept up to a certain value so as to maintain the arcs, if we have the characteristic of the machine we may determine the lowest speed at which it may be run and still do what is required of it.

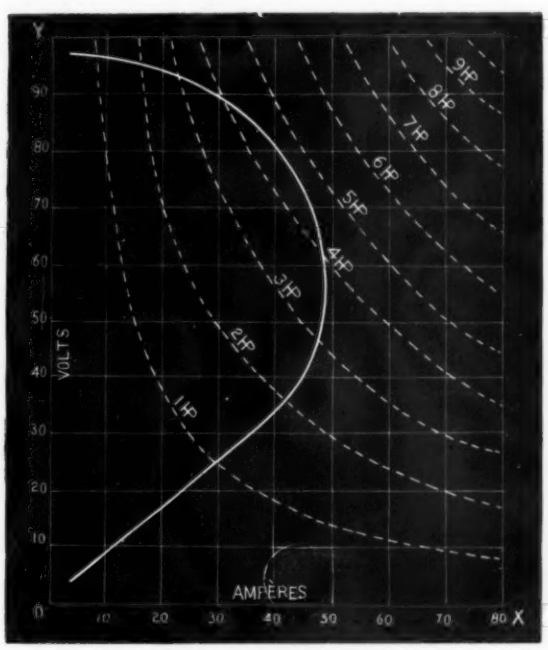


FIG. 2.—SHUNT MACHINE.

Let O, E, be the curve (fig. 4) at a given speed; mark off O, P = number of volts required, and draw Q, P, so that tan. O, Q, P = number of ohms resistance in circuit exclusive of the arcs. Draw Q, P′, tangentially to the curve, then the ratio of the lowest practicable speed to that at which the curve is taken is O, P to O, P′.

If P′ is above P the speed may therefore be decreased and *vice versa*.

Suppose a series dynamo is to be used for charging a set of accumulators. Draw the total characteristic for that speed, on O, Y, set off O, E, representing the E.M.F. of the accumulators, and through E draw a line making such an angle with O, X, that its tangent represents the resistance of the whole circuit; this line will cut the curve in two points, P and P′, and also if the characteristic is drawn when the current and E.M.F. are inverted, in P″ draw the corresponding ordinates P N, P N′, P N″. Then O, N, represents a current which

might exist, providing the resistance of the circuit did not rise; for if it did rise the E.M.F. of the dynamo would fall off, and the accumulators would overpower it.

O, N′, represents a current which would be stable within certain limits, and O, N″, the current which would flow if the dynamo were overpowered.

Series dynamos are unsuitable for charging accumulators on account of this liability to be overpowered.

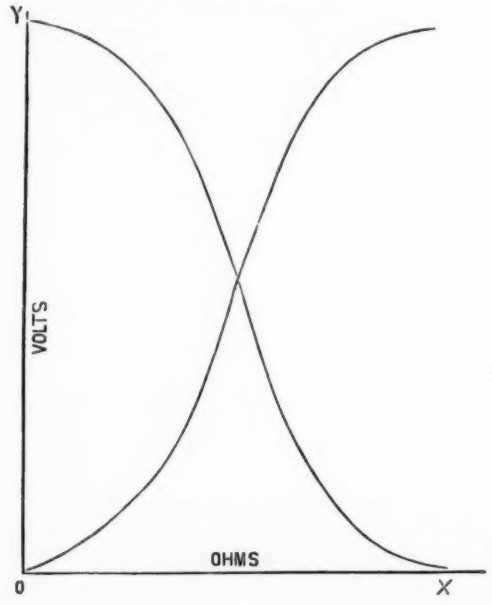


FIG. 3.

Shunt dynamos, however, are not subject to this disadvantage, for if the characteristic of a shunt machine be drawn (fig. 5), and also the line, E, P, it will be seen that if the resistance of the circuit increases either from heating or from the accumulators reaching their full charge, the current in the shunt and the E.M.F. of the dynamo will increase, so that there is no likelihood of the machine being overpowered.

Characteristics of Motors.—In a dynamo the internal characteristic is always above the terminal characteristic. In a motor the internal characteristic depends on the counter E.M.F. generated and is consequently always below the characteristic at the terminals.

The difference in the height of the ordinates of the two curves represents the E.M.F. occupied in overcoming the internal resistance of the machine itself. If a line be drawn making a negative angle with O, X, so that the tangent of this angle is numerically equal to the resistance of the machine and thus be regarded as a fresh base line, then the internal characteristic becomes the external one.

To study the working of a motor it is often convenient to draw some other curves, which may be called speed characteristics.

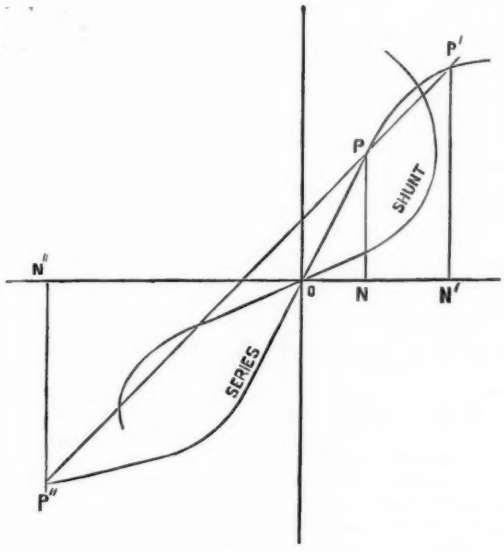


FIG. 5.

Suppose we have a constant E.M.F., then the faster the motor runs the less current will run through, and *vice versa*.

If the motor is prevented from turning, the current and consequently the electrical H.P. consumed will be greatest, but the motor will simply exert a statical effort and no work will he done. If, on the other hand, the motor is running light, its speed will be greatest and the only current passing, and the only electrical H.P. consumed will be that required to overcome the motor's own internal friction.

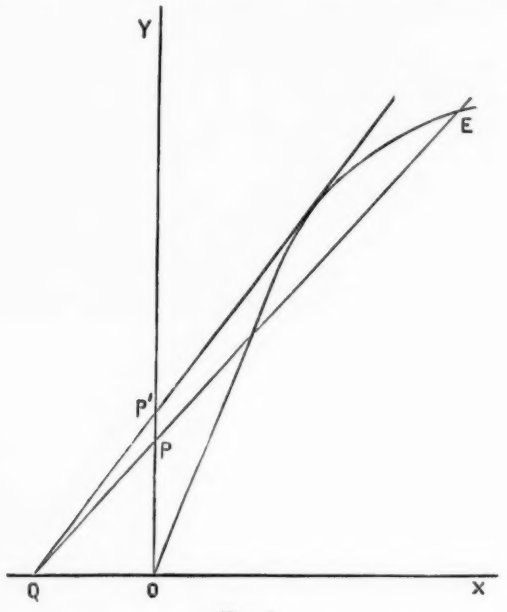


FIG. 4.

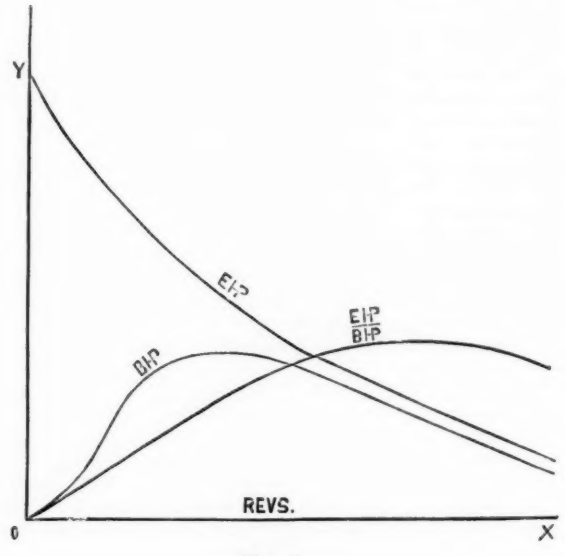


FIG. 6.

A curve may be drawn to show this in which the speeds are plotted as abscissæ and the electrical H.P. as ordinates.

In this way we get a curve (fig, 6) starting from a maximum H.P. on the axis of Y, and falling to a minimum H.P. and a maximum speed on the axis of X, *i.e.*, neglecting the friction of the motor. We may also plot another curve in which the horse-power indicated by a brake or dynamometer is plotted as an ordinate. This will start from the origin, rise to a maximum and fall again, meeting the axis of X again at the same place as the former curve.

This curve shows the maximum power of the motor. To find the point of maximum efficiency, the ratio of the ordinates of these two curves should be plotted vertically. This gives the efficiency as a function of the speed. It does not follow that the speed at which a motor is most efficient is that at which it does most work. The speed is generally greater, and a motor should be arranged so as to run as nearly as possible at that speed.

SELF-WINDING CLOCKS AND REGULATORS.

THE Self-Winding and Synchronising Clock Company, which owns for this country the patent of Mr. Chester H. Pond, has now established show-rooms and workshops at 52, Queen Victoria Street, London. The manager of the company is Mr. J. A. Lund, whose name is already well-known in connection with the regulation of clocks by electricity. Pond's self-winding apparatus was very fully described and illustrated in the REVIEW for October 17th, 1885, when it was first shown in London. Since that time the method has had continuous trial with many kinds of clocks and has proved thoroughly efficient, reducing the cost of maintenance to a minimum, while at the same time increasing accuracy of performance. The self-winding clocks and regulators are entirely automatic, being operated by a small battery which requires no attention for many months. The winding of a clock frequently and regularly not only shortens the "train" and greatly diminishes the number of parts, but also decreases the friction and strain upon it to the lowest degree. It does away with the necessity for a "maintaining power" as the spring is wound in the direction in which the "train" is moving, thus maintaining a perfect uniformity of tension. By these means perfect time is secured without the sacrifice of any of the advantages possessed by the ordinary key-wound clocks. With respect to turret clocks there are many positions which present insurmountable difficulty in the way of providing the space necessary for the fall of the weights and of convenience for winding. These difficulties are overcome by the patent under notice, and while the price of these self-winding movements are in many cases less than that of weight clocks, the heavy cost of maintenance is almost wholly eliminated. The conversion of clocks from the old to the new method can be readily accomplished, the case, dials, hands and in most cases a large portion of the old clocks being utilised for conversion with self-winding ones, the change resulting in great improvement in the going of the clocks. The show-rooms of the company are stocked with a variety of very handsome clocks in different styles to meet the usual requirements, ranging from the highest grade of astronomical movements to the common office clock.

The Phœnix Fire Rules.—We have received a copy of the 9th edition of these rules, which, on the whole, err on the side of stringency, but a vague uncertainty about many of them provides the elasticity so dear to the heart of the contractor, and, therefore, taking them all round, they do very well. We believe that where they are strictly complied with a fire from electrical causes would be impossible.

INCANDESCENT LAMP PATENTS.

EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY *v.* WOODHOUSE AND RAWSON.

Saturday, February 12th, 1886.

THE suit of the Edison and Swan Company against Messrs. Woodhouse and Rawson for the infringement of the Cheesbrough (Sawyer and Man) patent for the preparation of carbon filaments for use in incandescence lamps, it will be remembered, was tried before Mr. Justice Butt on May 20th, 1886, and following days. Mr. Justice Butt gave judgment for the plaintiffs, and the defendants appealed. The appeal was heard by Lords Justices Cotton, Lindley and Lopes, on January 21st of the present year. Judgment was delivered on Saturday last, supporting the decision of the court below.

The Attorney-General (Sir R. E. Webster, Q.C.), Mr. Aston, Q.C., and Mr. Fletcher Moulton, Q.C., appeared for the plaintiffs; Sir Horace Davey, Q.C., Mr. Macrory, and Mr. H. G. Rawson for the defendants.

LORD JUSTICE LINDLEY delivered the judgment of the whole Court as follows:—The plaintiffs in this case sue the defendants for infringement of a patent obtained by Cheesbrough in June, 1878. For the purposes of this action the patent may be described as for the production of a carbon for use in electric lamps. The kind of electric lamp—that is, whether an arc lamp or an incandescent lamp—is not stated, either in the title or claim, but in looking into the body of the specification it is reasonably clear that the patentee is referring to incandescent lamps, and those only. The patentee points out that nearly all obtainable carbon is open to objection by reason of its dissociated character, lack of homogeneity, and by reason of its occluding air or oxygen; in other words, by reason of its porosity. He points out that carbon of the ordinary sort, when heated by the electric current, presents points and lines of unequal brilliancy. He then shows how a carbon free from these defects can be obtained. His method is to heat a pencil of carbon by passing an electric current through it while in a hydro-carbon gas or liquid; he says that the heat required is as high as 7,000° Fahrenheit, and that carbon so heated decomposes the surrounding gas or liquid, the carbon of which enters and fills up the pores of the pencil and deposits a perfectly homogeneous layer, generally of a bright gray colour, upon the exterior surface. He says that carbons prepared by this process when heated by the electric current glow with a uniform brilliancy throughout. He says, further, that as the carbon increases in size more current is required to maintain its temperature, and that if the current is gradually increased in accordance with the demand for it there is apparently no limit to the increase in mass of the homogeneous exterior deposit, and that carbon pencils cut from this deposit on the original pencil may be used in the lamps. The patentee then claims the above method of preparing such pencils, and also the substance so prepared for electric lamps. Now it is not denied that pencils thus prepared are better than any before known for the purposes of incandescent electric lamps, and the defendants admit that they make carbon pencils for such lamps by electrically heating them while immersed in or surrounded by a hydro-carbon gas or liquid. The defendants do not admit that they keep up the temperature or increase the electric current, but the evidence shows that they cannot obtain what they want unless they do keep up the temperature and consequently increase the current. We therefore consider that the admission made by the defendants amounts to an admission of the infringement by them of the plaintiff's patent, if that patent is good. The defendants, however, contend that the patent is bad on various grounds, but mainly on the ground of want of novelty both as regards the process described and the substance produced, and in support of this contention they rely on certain experiments by Despretz and by Sidot. It will be convenient to deal with this head of defence first. In 1849, M. Despretz, in attempting to volatilise carbon by means of electricity in an atmosphere of carburetted hydrogen, decomposed that gas, and carbon was precipitated on the carbon he was attempting to volatilise, and in the whole apparatus the carbon experimented upon and the lamps were covered with lampblack, which was deposited in flakes: on removing these the carbon experimented on was found to be smooth, bluish gray, and larger than before. Despretz further observed that sugar charcoal, which is light, black, dull, and fragile, became, when experimented upon as above, denser, harder, bright, and *assez solide*—that is, rather solid, or solid enough. In his experiments Despretz used a battery of enormous power—viz., a Bunsen's battery of 600 cells. The carbon experimented upon was of various kinds — viz., the charcoal deposited in gas retorts, anthracite, graphite, charcoal prepared by calcining sugar, and charcoal obtained from turpentine. It also appears that sometimes he united the poles of his battery by threads or rods of carbon, and that at other times he suspended similar threads or rods vertically between carbon points at the poles. It is not quite clear which method he adopted in his experiments with carburetted hydrogen. The scientific witnesses examined at the trial apparently thought or assumed that the thread or rod connected the two poles. In considering this experiment it is important to observe that M. Despretz was attempting to fuse and volatilise carbon, and not to produce it or to make it in any shape

or form. With reference to his objects the experiment was a failure, and he treats it accordingly. He warns other persons desirous of pursuing his inquiries not to use carburetted hydrogen for the purpose. He pursued the matter no further; he gave no direction as to the best method of making carbon of any kind for any purpose, nor did he point out what precautions ought to be taken in order to avoid a general deposit of carbon over the whole apparatus. He saw that the carbon which he was trying to fuse and to volatilise became smooth, bluish gray, and larger, and that sugar charcoal became denser, harder, brighter and more solid, but his observations as to the changes undergone by the carbon went no further. He did not examine the porosity of his product; he was not aware of the fact, if it be a fact, that the carbon experimented upon had become less porous or had undergone any change which made it peculiarly useful for any purpose whatever. The fact, however, that the particluar form of carbon called graphite had been obtained by Despretz, or could be obtained by means of a less powerful battery than was used by him, was subsequently ascertained by Boltendorf, as appears from the "Jahrsbericht" or annual report on the progress of chemistry in 1870. That publication gives no further information on the subject. The rest of the evidence relating to Despretz's process consists of the testimony of the scientific witnesses on behalf of the plaintiffs. It is worthy of remark that no carbon produced by Despretz's process ever appears to have been made. No one has ever seen it. The defendants did not produce any carbon so made. No one, in truth, knows anything more about it than Despretz himself published. The burden is on the defendants to show that Despretz's process is the same as the patented process, and to show that the substance obtained by him was in all respects the same as the substance claimed by the plaintiffs. The defendants have adduced no evidence to establish either of these propositions beyond what the plaintiffs' witnesses themselves stated on cross-examination. We have therefore only to examine their evidence, and we have carefully done so. Without referring at length to it, we consider: (1) that before the date of the plaintiffs' patent no one had ever intentionally made or attempted to make carbon for any purpose whatever by Despretz's process; (2) that Despretz's process is not a practicable method of obtaining non-porous carbon for any useful purpose; (3) that so far as can be inferred without actually making carbon by Despretz's process the carbon experimented on by him must have been superficially charged with graphite similar in all respects to that obtained by the plaintiffs; (4) that there is no difficulty in making carbon fit for incandescent electric lamps by following the directions contained in the plaintiffs' patent; (5) that carbon made according to the plaintiffs' patent is better adapted for incandescent electric lamps than any other form of carbon known at the date of the patent, and that this fact was never known to or suspected by Despretz or anyone else until discovered in 1878 by Sawyer and Mann, who communicated the discovery to Cheesbrough, the plaintiffs' assignor. In this state of the evidence we can only come to the conclusion that for all useful and practical purposes the processes are different and the products are different. By following Despretz's process carbon, resulting from the decomposition of carburetted hydrogen, is deposited over the whole apparatus, and is wasted; whereas by following the plaintiffs' process the carbon is deposited where it is wanted and utilised. The substance obtained by Despretz was a mere scientific curiosity of no known utility whatever; whereas the substance obtained by the plaintiffs is shown to be a valuable article of commerce, of great utility for the purpose of illuminating by incandescent electric lamps. It may be true that Despretz produced graphite, and that the plaintiffs produced graphite, and that long before 1878 graphite was used for incandescent electric lighting, but the fact still remains that of all the known forms of graphite that made by the plaintiffs' process was, in 1878, the best for the purpose they mention, and the carbon got by Despretz's process is not shown to be structurally the same as that made by the plaintiffs, nor that that which Despretz got was non-porous. Such being the view we take of the evidence it becomes unnecessary to decide what the consequences would have been if the defendants had succeeded in showing that the material produced by Despretz was non-porous and in all respects the same as that produced by the plaintiffs' process. We express no opinion whether in the case supposed the plaintiffs' patent would be bad, inasmuch as it showed how to apply to a useful purpose carbon which neither Despretz nor anyone else was aware had the specially useful qualities discovered by the patentee. When such a question arises it will be necessary to consider such cases as "Walton *v.* Potter" (1 Web. Patent Ca., 585), "Walton *v.* Bateman" (*ib.*, 613), "Muntz *v.* Foster" (2 Web. Patent Ca., 108), on the one side; and "Losh *v.* Haynes" (1 Web. Patent Ca.), and "Harwood *v.* the Great Northern Railway Company" (11, H. L. C., 654), on the other. As regards Sidot's process little need be said. His process was entirely different, for he used external heat. The substance he produced, though in one sense the same as that obtained by the plaintiffs, was not so dense and was very inferior to theirs for the purposes of illumination by an incandescent electric light. The difficulty in upholding the plaintiffs' patent turns entirely on Despretz's experiments and not on Sidot's mode of making carbon pencils for arc electric lighting. It remains to consider the objections to the specification and claim. One is that the expression carbon gas or liquid in the claim is ambiguous and too wide and misleading, and it is urged that the expression includes carbonic oxide and carbonic acid, neither of which will do. But every claim in every patent must be read and construed with reference to the specification and not as if the claim were an isolated sentence having no connexion with or reference to what precedes it. To see what is meant by carbon gas or liquid we must turn to the specification; and when we do so we cannot conceive that any one reading this patent fairly, with a view to understand it, would ever dream for a moment that carbonic oxide or carbonic acid could answer the purpose or could be meant by carbon gas. The specification clearly points out that carbon is to be deposited, and the presence of oxygen is to be avoided. Reliance was placed on an answer of Sir F. Bramwell. What he said in effect was, You had better put your question to the chemical witnesses and not to me. The chemical experts, as might have been expected, ridiculed the notion that anyone would think of trying carbonic oxide or carbonic acid. In the body of the specification we find that by carbon gas or liquid is meant what the patentee calls a hydro-carbon gas or liquid, and he states that beeswax, balsam, most oils, if pure, operate satisfactorily, and that almost any hydro-carbon will answer. The appellants, on this, urge that beeswax and balsam and oils are not, properly speaking, hydro-carbons, and that the specification is inaccurate and misleading. The evidence shows that in its technical sense a hydro-carbon is a chemical combination of hydrogen and carbon and nothing else; and that beeswax, balsam, and oils are not technically hydro-carbons. They contain hydrogen and carbon chemically combined with each other, but also with other substances. But the evidence also shows that, so far as is known, every substance which is a hydro-carbon either in its technical sense or in the looser sense in which the patentee uses the expression, does answer the purpose; and there is no evidence that anything which answers the description of hydro-carbon in either sense will not answer the purpose. In this state of the evidence it is impossible for the Court to say that the specification is open to serious objection, or is insufficient on this ground. The next objection that requires notice is that it is contended that the evidence shows that it is essential to success to increase the temperature gradually, and that the specification is insufficient because it does not point this out. Now the evidence certainly shows that the maintenance of a high temperature is that which distinguishes Cheesbrough's process from Despretz's experiment, and although Prof. Dewar points out the importance of a gradually increasing current, neither he nor any other witness says that the temperature ought to be low to begin with and be gradually raised. Their evidence comes only to this—that the temperature must be kept up and the electric current must be increased or the temperature will fall. But the patentee himself tells you this. He says that the temperature must be as high as 7,000° Fahr., and the sentence in the specification "as the carbon increases in size more current is required to maintain the temperature," is shown by the evidence to be useless and an obvious truism to those who understand the subject, unless the sentence is understood to be a direction to keep up the temperature; and when we find that in fact no difficulty is experienced by reason of defective instructions on this point, the court cannot hold as a matter of law that the specification is not sufficiently explicit. If the defendants had shown that the directions as to temperature were not practically sufficient to enable a competent person to make the patented articles the case would be very different; but they have not attempted to do this; they rely on the words used and on the evidence as to temperature already alluded to. This, in our opinion, is not sufficient for our purpose. If the language of a specification is clear enough to guide a competent workman and enable him to obtain the desired result, we cannot see how a court can hold the language insufficient in point of law. No doubt it is for the court and not for a workman to construe the specification; but if a workman says it is a sufficient guide to him and the court believes him, the court must hold that as regards clearness of description the specification is, in point of law, sufficient. For the foregoing reasons we are of opinion that there is sufficient originality and novelty in the patented process to support the first claim, and sufficient difference in the thing produced to support the second claim. The appeal is therefore dismissed.

Mr. ASTON: With costs, of course?

LORD JUSTICE COTTON: Yes, of course.

Sir HORACE DAVEY: There is an existing arrangement, which relates not only to this patent, but to the other, by which on payment of a certain royalty—I need not mention the amount—the injunction is suspended until the delivery of the judgment in this appeal. Your lordships will understand that my clients may desire to consider whether they will pursue the litigation further or not. I am not in a position to ask, and my learned friend (Mr. Aston) is not in a position to consent—I could not fairly ask for an absolute suspension of the injunction, but I might ask that the existing order might continue for a fortnight, to give my clients time to consider whether they will go further or not.

LORD JUSTICE COTTON: That seems reasonable.

Mr. ASTON: I am sorry to say with regard to the arrangement which Sir Horace Davey has referred to, that the defendants have not performed their part.

Sir HORACE DAVEY: Well, Mr. Aston, very large sums indeed have been paid.

Mr. ASTON: Your lordships were prepared, I believe, if we had asked you, when judgment was given in the first case to grant the injunction. But of their own accord the plaintiffs instructed me to consent to what appeared to be a reasonable arrangement on the part of Sir Horace Davey, that the interval between the judgment in the first action and the judgment in the second

might be utilised by the defendants in considering their position. They knew perfectly well that they were open to the possibility, I will say, of having a decision against them, and therefore they ought to be prepared to-day. On two grounds I am instructed to oppose this application. The first is that as far back, I believe, as January 28th of this year a notice was served on the defendants that an application would be made to the court to order the defendants to pay what had become due, under the arrangement entered into, on account of accruing royalties. There was at that time £1,300 due. Luckily they then paid a small amount. They have not only themselves opposed us, but have asked for subscriptions from other manufacturers to continue this litigation, and they are therefore not in a position to ask for a continuance of that favourable consideration which up to this time the plaintiff company has afforded them. Under these circumstances I stand upon the rights of the plaintiffs. If your lordships require authority for the fact that the plaintiffs are entitled now as of right to the injunction—

LORD JUSTICE COTTON: I do not think you need go into that. The only question is, what is it reasonable to do while the appellants decide whether to go to the House of Lords or not?

Sir HORACE DAVEY said £1,816 9s. 6d. had been handed over to the plaintiffs. The defendants had actually paid the sum of £250 since January 28th.

Mr. ASTON: On account of £2,000. I hope your lordships will not, in opposition to the express desire of the plaintiffs that their rights shall be enforced by the Court in accordance with precedent and authority—I hope your lordships will not put upon them these terms. If the injunction does issue it will be quite open to the plaintiffs to consider any application the defendants may make even then. I think I am justified in saying that the plaintiffs would be at all events advised to entertain a proposition that is fair. It is not the first time that the plaintiff company has so done. I have here a statement in an affidavit which the defendant himself has lodged, that it was offered them, I believe after some negotiation, in July, 1886, to work under a licence from the plaintiff company. But they wanted a licence upon terms that would not recoup the plaintiffs the large outlay of between £300,000 and £400,000 which has been made in putting this invention fairly into operation. Therefore, we are really asked on all hands to make concessions, concessions are made, and we are met by hostility being stirred up amongst rival manufacturers.

LORD JUSTICE COTTON: These defendants, I suppose, are prominent names, but I suppose there are a great many people in the same position.

Mr. ASTON: I might ask to read this affidavit of Major Flood Page, of 13, Albert Mansions—

Sir HORACE DAVEY: Is this fair?

Mr. ASTON: We have given notice. There is an affidavit on one side by Mr. Rawson, and of course that is met by an affidavit by Major Flood Page. [Mr. Aston proceeded to read the affidavit of Major Flood Page, which, after stating the effect of the judgment of Mr. Justice Butt and the terms of the undertaking between the parties by which Messrs. Woodhouse and Rawson agreed to pay a royalty of 1s. 6d. per lamp upon all lamps manufactured by them, declared that the defendants had not complied with the terms of the said undertaking. The defendants paid on account £233 8s. on September 23rd in respect of lamps made from August 10th to September 9th, and £333 1s. 6d. on October 30th in respect of lamps manufactured from September 10th to October 9th, but up to January 28th no further payment had been made. The plaintiffs had received nothing from royalties in respect of lamps manufactured or sold between the date of the judgment and August 10th, or from October 10th to October 31st, or in the months of November, December and January, notwithstanding repeated applications. On January 28th Major Page caused a notice to be served upon the defendants, and on the same day received a cheque for £250 only on account, and without any statement or account showing what sum was actually due. The plaintiffs believed that considerable sums were due from the defendants on account of the undertaking, estimating the indebtedness to be, for each month in respect of which no payment had been made, at least as much as was admitted to be due in respect of each of the months from August 10th to October 9th. The affidavit went on to state that prior to the hearing of their appeals the defendants called a meeting of persons interested in electric lighting, and asked for subscriptions for the purpose of contesting the appeals on the ground that they (defendants) were not able of their own resources to prosecute such appeals, and subscriptions were obtained from those other persons.] The fact is, my lord, they have not paid royalties for five months.

LORD JUSTICE COTTON: There would be no difficulty, I suppose, Sir Horace, in your clients rendering an account of what they sold, and therefore of the sums due on account of royalty?

Sir HORACE DAVEY: I am told that my clients can render an account. They have been busy both with these appeals and in making up their accounts; but they will render an account in ten days. I am not asking for a suspension of the injunction pending an appeal to the House of Lords, but only for a continuation of the present order for a fortnight.

LORD JUSTICE COTTON: If they will undertake in ten days to render an account of the lamps sold, and to pay the balance then due, then we will suspend the judgment for a fortnight on that undertaking.

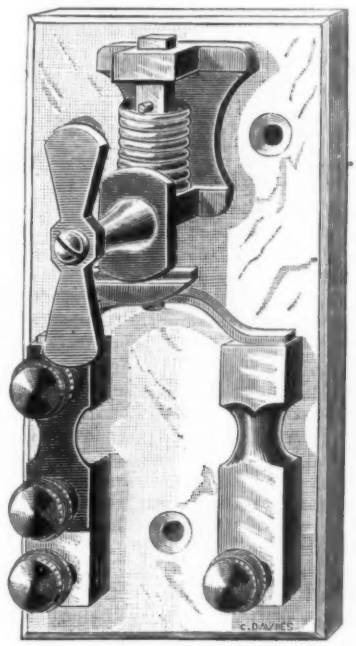
Mr. ASTON: I only wish it to be distinctly understood that the other injunction was suspended until to-day only.

Sir HORACE DAVEY: That I have said.

ROSE AND CO'S. SWITCH.

THE illustration shows the switch to which we alluded in our last week's "Notes," the principal features claimed for it being (1) pressure is secured on the surfaces in contact; (2) freedom from shocks; (3) non-liability to derangement; (4) instantaneous breaking of the electric circuit.

A number of these patent switches, in sizes varying from the 1 to 200 lamp type, are now in use by eminent firms of electrical engineers and are giving satisfaction. They are mounted on wood or slate bases, and are manufactured with or without cut-outs as ordered, and the larger sizes substantially mounted on slate have proved effective as dynamo main switches.



In the drawing the circuit is represented as closed, but when the handle is turned to the horizontal position the circuit is broken, the spiral spring acting very rapidly and well.

We would suggest, however, that if the contact springs, instead of being allowed to merely rest with a certain pressure upon the tops of the metal blocks, were made to rub along their respective sides, the apparatus would be still more reliable. We could readily imagine the switch as now made failing in its duty through the lodgment of dirt between the contact surfaces, or from oxidation due to sparking.

REVIEW.

L'Année Electrique: un exposé annuel des travaux scientifiques des inventions et des principales applications de l'électricité a l'industrie et aux arts. Par PH. DELAHAYE. Troisieme année. Paris: Baudry et Cie., 15, Rue des Saints-Péres.

Those who wish to get a fair general idea of the progress which electrical science and its applications is making from year to year can hardly do better than read M. Delahaye's year-book. Considering the amount of ground which has to be gone over in order to compile a work of the kind, the result is very satisfactory, although there are inevitably many omissions. It would be an improvement, we think, if the work contained notes indicating from what periodicals, &c., the matter given is gleaned, so that fuller information on any particular subject may be readily obtained by the reader if he so desires.

NOTES.

The Electro-Harmonic Society.—We are informed that the forthcoming concerts of this society will be given in the Banquet Room at the St. James's Hall Restaurant, Regent Street on March 25th, April 29th, May 27th, and June 24th. In explanation of the lateness of the last date, it may be mentioned that it is hoped that on account of the Jubilee many electricians from the colonies and British dependencies will be in London about that time, and an opportunity will then be given for friendly meetings between them and their English *confrères*.

The Loeb Chemical Electric Light Company, Limited.—With a view to united action, creditors are requested to send their names at once to Mr. H. Alabaster, the ELECTRICAL REVIEW Office, 22, Paternoster Row.

Proposed Electric Lighting at Exeter.—The extension of electric lighting in the West of England has, of late, been remarkably satisfactory. After successfully conducting experiments at Plymouth, which will probably bear good fruit, Messrs. Laing, Wharton and Down have now extended their operations to Exeter, where arrangements are in progress for the experimental illumination, by means of electricity, of several public and semi-public buildings. Mr. Herbert-Basing, of the theatre in Longbrook Street, has decided to test the suitability of the electric light for dramatic representations, and if the trial is as favourable as is anticipated, there is reason to believe that the illuminant will be permanently adopted. The improvement would be gladly welcomed, as the supply of gas has not lately been all that could be desired. Few provincial theatrical managers have had the foresight to adopt a more reliable and brilliant light than that generally in vogue, and it would, therefore, be rather a feather in Mr. Herbert-Basing's cap if he decided upon taking advantage of that which would impart to the stage mountings and accessories a brilliancy of appearance which can now only be obtained by much more costly means.

Fatal Fire in an Electric Light Station.—It is said that investigation into the cause of the fire in the electric lighting station at Providence, R.I., by which the engineer and fireman lost their lives, shows that the fire did not originate from the electric wires. The strike of the coal handlers had induced a scarcity of anthracite coal. Soft coal was used, and the dynamo room became filled with gas, which exploded.

Lighting Passenger Cars.—The Boston and Albany railroad is said to have as good a system of heating its cars as any yet practically applied, and it is now experimenting with a system of heating with steam from the engine which promises to prove even better than the system now in use. It has tried, or rather has permitted inventors to try, various methods of lighting its cars with electricity. Heretofore these attempts have failed when put into practical operation, the use of primary batteries having been the principle employed. Now, however, a new way is being tested, and apparently it is to prove a success. At the first test a car was fitted up with 10 incandescent lamps of 25 candle-power, while each platform is lighted by another lamp. Two storage batteries were placed in suitable receptacles under the car, and these batteries were said to be sufficient to supply the lights 8½ hours. The Julien Electric Company, of New York, equipped the car under the personal supervision of Mr. Woodworth, agent of the company, and Mr. C. M. Wilder, its Boston resident electric engineer. Mr. Julien is said to have invented a new metal for the supporting plates whereby the life of the battery is almost indefinitely prolonged; and that experiments have shown that, after 18 months use, they are as healthy and serviceable as when they were made.

An Interesting Electric Lighting Station.—We hear that a considerable extension of lighting from the Pilsen Company's Central Station, to which we alluded last week, is under consideration. The Inns of Court Hotel will require an addition of 100 lamps for bed rooms, and Webb's restaurant, the "Radnor" tavern, and Guest's wine stores at the Holborn end of Chancery Lane, are to be electrically lighted. All this will necessitate the employment of something like double the horse-power now available.

The "Untied" Telephone Company.—In days gone by we have uttered protest upon protest against the manner in which the United Telephone Company discharges its functions. The telephone service became so uncertain and so generally unsatisfactory that we finally severed our connection with the exchange. Since that time no improvement seems to have been effected; indeed, matters have grown worse, if all accounts be true, and the *Financial News* is directing its powers of sarcasm at the heads of those responsible for the proper conduct of the telephonic business of the metropolis:—"We hear," says that journal, "that a telephone census is about to be taken in the City in order to ascertain what number of instruments are in actual operation. Of the four thousand odd subscribers of the United Telephone Company it is known that a large proportion are, as the Methodists say, 'out of fellowship.' In this office we have not been able to speak to our printers through the telephone for two months, though they are no farther away than Fleet Lane, and we keep an extra telephone specially for that service. While it has been suspended we have paid away more than the annual subscription in cab and passenger fares, which we shall of course expect the United Telephone Company to reimburse us. We know many other offices in the City where they cannot speak, beyond 10 minutes from the Bank, and even there they can communicate quicker by messenger than by telephone. As for the West End and the suburbs they have been blotted out of the telephone map of London. No one dreams of speaking so far nowadays, but at the next meeting of the company people may be coming from considerable distances to speak their minds to the board without the help of telephones. City men want to know who is the resident responsible head of this left-handed white elephant. The directors are, like Brutus, all honourable men; but they have all businesses of their own to attend to, 'such as it is.' The question is, whose special, peculiar and exclusive business is the management of the United Telephone Company's wires? He is the man who has to be got hold of, be he in London or Liverpool or in the moon, and United Telephone subscribers are all anxious to interview him."

The Telephone in Renfrew.—The National Telephone Company is extending its system to Larbert and Renfrew.

The Telephone at Galashiels.—The National Telephone Company has made an offer to the Town Council of the burgh of Galashiels to attach the houses of the members of the burgh fire brigade—eight in number—to the police office, for £20 per year, on a five years' agreement.

The Government and the Telephone Companies.—In the House of Commons on Thursday last week, Mr. Watt asked the Postmaster-General whether he was in a position to state what progress had been made in any negotiations which might be pending between the Government and the telephone companies with a view to the acquisition and extension of the present lines and the removal underground of all existing overhead wires; as also with a regard to the public service by improving the present most inadequate and defective arrangements. Mr. Raikes said no negotiations were pending for the acquisition by the Government of the telephone systems of the various companies carrying on business in the United Kingdom. The Post

Office continued the practice, which had been adopted for many years past, of substituting underground for overhead wires in London and other large towns whenever the number of wires was considerable. The length of underground wire in the United Kingdom was upwards of 20,000 miles, and the main trunk lines from London were carried underground to distances varying from five miles to 22 miles from the General Post Office. The principal and many of the smaller offices in London, 315 in all, were connected with the central telegraph office by underground wires. As the hon. member was no doubt aware, the telephone system in London did not belong to the Post Office, but to a private company, to whom any question of improving the present arrangements should be addressed.

"Dynamo" Telephones.—Mr. J. P. McLaughlin, of Philadelphia, states that he has anticipated the invention of Prof. Silvanus P. Thompson, to which the above name has been given. His patents, he says, completely cover the use of a magneto machine and a dynamo for and in the art of telephoning. An ordinary generator is used which serves the use of call bell, transmitter, receiver and battery combined, and by means of an *alternating current of opposite polarity* sufficient energy is evolved to permit conversation over many miles of line wire with wonderful clearness of articulation. Once put up, the machine will last, says the inventor, until—well, until the patent expires, without any attention whatever. The simple act of calling up the exchange or any subscriber reinforces the magnetism of the field magnets and keeps the machine always in first-class talking order. "Altogether," he concludes, "I think it is unique in its simplicity and ease of demonstrating that conversation can be carried on through an instrument without the much lauded and much claimed undulatory current of historic 'fifth claim.'"

Telephoning between Paris and Brussels.—The Bourses of Paris and Brussels are now connected by telephone. The line, we learn from *Industries*, is formed of two silicon bronze wires of 118 mils. diameter, one wire serving for the out and the other for the home circuit. To avoid induction, the wires are crossed at 90° at every pole, so as to make a complete revolution round each other at every fourth pole. A small portion of the line—as far as it lies within the city of Paris—is placed underground.

The Grievances of Telegraph Clerks.—A largely attended meeting of the first-class telegraph clerks attached to the Central Telegraph Office was held on Saturday evening for the purpose of considering what evidence should be laid before the Royal Commission of inquiry into the Civil Service. The appointment of the provisional committee having been confirmed, a long discussion took place on the grievances of the staff in general. It was unanimously resolved that the committee should co-operate with the second-class committee and request the uniting of all the other classes in the movement, and that a meeting of the whole staff be held at an early date, so that a general consensus of opinion may be arrived at.

Indian Telegraphs.—In answer to Mr. King, in the House of Commons on Tuesday, Sir J. Gorst said a scheme relating to the Telegraph Department in India was prepared by the late Secretary of State in Council and transmitted to India on July 8th, 1886. The Government of India was authorised to give effect to it if, after obtaining the views of the Commission which was now considering the possibility of effecting reductions in the public expenditure, they should think it right to do so. The Secretary of State had recently requested the Government of India to obtain a report on the subject from the Commission. Until the decision of the Government of India was received it was impossible to give information to the House as to the nature of the communications that had taken place.

Multiplex Telegraphy.—Multiplex working, *Industries* says, will shortly be introduced on the line between Vienna and Krakau, the system to be adopted being that of Herr Granfeld, which includes the use of Lacour's phonic wheel,

Cable Broken.—A section of the West African cable has been ruptured off the Congo. It is expected that a repairing ship will start from Silvertown to-morrow.

Cable Laying on the African Coast.—Mr. J. Y. Buchanan, of the *Challenger* expedition, dealt with this subject in a lecture which he delivered to the members of the Scottish Geographical Society at Edinburgh this week.

Obituary.—It is with regret that we announce to our readers the death of Madame la Comtesse du Moncel, widow of the late director of *La Lumiere Electrique*. Her constant and untiring assistance, and especially her perfect acquaintance with foreign languages, were of the greatest value to her husband in the literary works in which he was engaged during the latter part of his scientific career, and which are essential to every French electrician.

The Society of Telegraph-Engineers and Electricians.—The next meeting will be held on Thursday, February 24th, when the discussion on "Telephonic Investigations," the paper read by Prof. Silvanus P. Thompson, B.A., D.Sc., member, will be concluded.

Useful.—It is stated that Mr. A. Gay, electrician, of Barnstaple, has patented an apparatus for extracting iron from china and stone by means of electricity. He has been engaged by a company to make experiments, as a result of which it was found that 98 per cent. of iron could be removed from clay, thus preventing the quality of the pottery from being injured.

Henley's Telegraph Works Company.—We learn that this company is about to engage in the manufacture of wire, and that the works at North Woolwich are now being fitted with the necessary machinery.

Woodhouse and Rawson Electrical Supplies.—We have just received from the Woodhouse and Rawson Electrical Supply Company its complete price list, which is one of the most comprehensive recently published. The greater portion of the book is devoted to special electrical supplies such as the W. and R. incandescent lamps, switches, cut-outs, electrical instruments, the Jensen electric bell system, &c. The particulars of the Upward battery, the new electric gas lighting appliances, and the Welsbach gas burner are given in separate lists. Besides the company's own specialities, full particulars are given of all the leading articles used in the electrical trade. The company aims at keeping in stock and supplying every article that is used in connection with electricity, so that people who do not make a speciality of the trade may always know where to buy the hundred and one odds and ends that are required.

The Guthrie Memorial.—The Guthrie Memorial Fund, which will shortly be closed, has now nearly reached the sum of £1,400. *Nature* states that Prof. Guthrie was too exclusively devoted to teaching and scientific research to be able to make adequate provision for his family. The object of the fund is to place his children as nearly as possible in the position they would have occupied but for his untimely death.

South Metropolitan Gas Stock.—One day this week, at the Auction Mart, Mr. G. A. Wilkins submitted for public competition £50,000 five per cent. debenture stock in the South Metropolitan Gas Company. All the lots were eagerly bought at from £134 to £135 for £100 stock, representing a premium value of between 30 and 40 per cent.

The Vienna Electrical Society.—On the 9th inst., Mr. A. Reckenzaun, who is slowly recovering from his recent severe indisposition, lectured on "Secondary Batteries," before the Electrical Society of Vienna. Mr. Reckenzaun spoke for an hour and a quarter to a large gathering of scientific men, and in the discussion which ensued, and during which several new points were raised, Hofrath von Grimburg (Privy Councillor), a high scientific authority; Baron Gostkowsky; Mr. Kohn, chief electrician of the South Austrian railways; Mr. Kolbe, C.E.; Baron Pfungen; Mr. F. Fisher, C.E., and Messrs. Karnblüh and Klose took part.

The Vienna Technische Hochschule.—On the morning previous to Mr. Reckenzaun's lecture before the Vienna Electrical Society, that gentleman was invited to inspect the technical high school in the same town, the most important in Austria. Dr. von Waltenhofen and Mr. Peukert, both of whom are well known to our readers by the articles which have appeared from time to time in our columns, conducted Mr. Reckenzaun through the various departments of the school. He describes the arrangements for electro-technical studies there as being superb. One instrument he describes, by means of which students can at once readily realise by ocular demonstration what they would with difficulty understand through books, is a balance. At one end of the apparatus is suspended a solid rod of iron dipping into the hollow of a solenoid; at the other end is an iron tube dipping into a precisely similar solenoid. When *weak* currents pass through the coils the solid bar pulls the lever down on its own side; with *strong* currents, the iron tube gains the ascendency, while with a medium current equilibrium can be obtained. This shows forcibly the effects of solid *v.* hollow iron cores.

Retrenchment, but not Reform.—It is stated that in consequence of the financial difficulties of the Bristol College, and lack of endowments, the salaries of all the professors will be reduced by the council, and some Chairs are to be abolished.

The Jensen Electric Bell and Signal System.—On Tuesday the Jensen Electric Bell and Signal Company issued an invitation to those interested to inspect some excellent specimens of its manufactures at its recently-opened showrooms. The samples shown were stated to be intended for shipment to America to be used for railways, telegraphs, hotels, private houses, &c. The most striking features of the examples shown were their artistic design and excellent workmanship. The Jensen bell has already been favourably noticed in our columns, its chief peculiarities being that instead of the unsightly box and gong, a bell of the ordinary church-bell form is used, inside of which are the magnet armature and hammer. In the matter of sound, also, these bells are a contrast to the common electric bell, as they give a perfect musical tone. Every effort is being made by the company to meet the demand for bells and accessories which are of themselves decorative, as will be seen from the following list of styles for brackets: in wood, the perpendicular Gothic, the semi-Gothic, the Classical, the Lych Gate, the Nuremberg, the Tudor; and, in hammered ironwork, the Quentin Matsys. The perfect way in which the armature and hammer are balanced renders it possible to ring a large bell with very little battery power, so that the system is applicable even in the case of a peal of church bells. The Jensen combination push-bell is an arrangement by which a person ringing receives an audible intimation that his signal has been seen and attended to. The showrooms of the company contain many interesting applications of the system and are worth seeing.

Electrical Work in the Navy. — Lord George Hamilton states that there are as many men employed in the electrical shop at Portsmouth as can profitably be put upon the work required.

The First Telephone Message Across the Channel.—An interesting discussion took place at the Dover Corporation meeting on Wednesday upon an application from the United Telephone Company to erect a pole for their wires abutting on one of the main thoroughfares. One Councillor (Mr. Bottle) objected to the overhead wires as being incompatible with this age of progress, and advocated the underground system. Councillor G. Fry, who said he was formerly engineer to a telephone company, said there was nothing incompatible with progress in the overhead wires for the telephone. Underground wires for the telephone for any considerable distance, except at a ruinous expense, would be impracticable. Mr. Bottle dissented from these remarks. He said the first telephone message delivered in this district was sent across the Channel some years ago by means of the submarine telegraph wire. He was present with several other gentlemen at St. Margaret's, near Dover, where they then witnessed the reception of a message from the French coast. That wire not only passed underground, but under the sea. Mr. Fry pointed out that this might be quite correct, but the transmission of such messages would be intermittent, and telephonic communication under these conditions could not be depended upon. The Council in the end granted permission to erect the pole. The telephone is making great progress in Dover, and new subscribers are daily being added to the list. It is of great service to business people between Dover and Folkestone where there are exchanges.

Electric Tramcars.—Last Monday the Bill empowering the North Metropolitan Tramway Company to employ electricity on its lines was passed in the House of Lords, and within a short time it is expected that Mr. Elieson's electric locomotives will be in regular operation on the Romford Road.

Fire at Henley's Telegraph Works.—We last week stated that a fire had occurred at the works of the Henley Telegraph Works Company. The manager informs us that the business has not been interfered with, the building in which the fire broke out being a store at some distance from the actual works.

Incandescent Lamp Litigation in America.—The Edison Electric Light Company, of New York, has begun in the United States Circuit Court at Trenton, eleven separate suits against Westinghouse, Church, Kerr & Co., of East Orange, N.J., representing the Westinghouse Electric Company, of Pittsburg, Pa., for alleged infringement of patents covering the system of incandescent electric lighting. Injunctions and orders requiring accounts from the defendants are asked for.

The Cowles Smelting Process.—It is stated that works are to be erected in this country to carry out the Cowles electric smelting process, which has been described in previous issues of the REVIEW. Messrs. Crompton & Co. have been instructed to build a dynamo 50 per cent. larger than the "Colossus" made by the Brush Company, and now running at Lockport, New York. Two other dynamos, each of which is to have a minimum working capacity of more than half a million watts, are being contracted for. They will each require over 800 H.P., and altogether the plant will involve the erection of engines capable of yielding 3,000 H.P.

Electrical Engineering Class at Edinburgh University.—On Saturday last a class, to be conducted by Mr. A. C. Elliot, B.Sc., under the superintendence of Professor Armstrong, in the practical applications of electricity to lighting, locomotion, transmission of power, and telegraphy, was opened in the engineering class-room of the Edinburgh University. The class originated as an extension of the additional course of lectures on special subjects introduced in connection with the Engineering Chair last year.

Exterior Theatre Illumination.—Messrs. E. L. Berry and Co. have lit up the outside of the Royal Comedy Theatre, using four 1,000 C.P. arc lamps, a 2½ unit Goolden and Trotter dynamo, and a 2 H.P. Marshall vertical engine and boiler.

Snowstorms and Wires.—Snow fell heavily in the north of Spain last week, interrupting the railway and telegraph lines.

Electric Lighting in India.—Mr. Killingworth Hedges, who is at present in India, in an article which he has just contributed to *Industries*, states that there is just now a deadlock in electric lighting in that country. An installation of the Brush system was, until quite recently, in operation in Bombay, but the liquidation of the Eastern Electric Light Company, and the stringent regulations with regard to overhead conductors, have led to its abandonment, to the disappointment of both European and native population. There are special difficulties with regard to insulation to contend against in India. During eight months of the year the insulation occasions no trouble, but during the remaining four months, which is the monsoon period, the rainfall is continuous, and at Bombay was found not only to cause a great amount of leakage in the overhead cables, but also to stop the working of mains laid in water-tight pipes, owing to the condensation which took place in the interior of these conduits. In the summer months little light is required, and even during the winter the demand is small, for it is the custom in mills and factories to work from sunrise to sunset only. The native population hardly require artificial light, and the European inhabitants live out of the cities in bungalows, which are too scattered to render the expense of laying mains remunerative. The Electric Lighting Act in force was framed from the English Act of 1882, and therefore restrains the development of the industry there in the same manner that its prototype does in this country. A Telegraph Act was passed in 1885, authorising the placing of telegraph lines on posts, and it is hoped that the new Electric Lighting Act which is in contemplation will confer similar privileges with regard to overhead conductors for electric lighting. There are already many private installations in clubs and factories; and some of the wealthy natives have their houses lighted on gala occasions, having purchased the necessary plant. Mr. Hedges thinks there is a great deal to be done in street lighting, as, with the exception of the three principal cities and the town of Jeypore, there are no gas works. In most Indian towns the streets are lighted in a very desultory manner by paraffin lamps, which are extinguised at midnight, and the rest of the town is always in darkness.

NEW COMPANIES REGISTERED.

New Electric Light Syndicate, Limited.—Capital: £16,000 in £10 shares. Objects: To carry on business as electrical engineers, manufacturers, and contractors, and for such purposes to adopt an agreement of 8th inst. between C. Maltby Newton and Alfred William Hornblow. Signatories (with one share each): S. Tugman, Primrose Club, St. James's; C. Maltby-Newton, C.E., Maidenhead; C. D. Singer, 47, St. Mary's Axe; Mrs. M. Tugman, 98, Junction Road, N.; T. Borras, 8 and 9, St. Martin's Lane, E.C.; J. Rogers Creasey, Sidcup: H. F. Hall, 111, Queen's Road, Dalston. Directing qualification: 25 shares. The company in general meeting will determine remuneration. Registered 8th inst. by H. F. Hall, 111, Queen's Road, Dalston.

Winfields, Limited.—Capital: £160,000 in £5 shares. Objects: To take over the business of R. W. Winfield and Co., of Birmingham and Holborn Viaduct, and to trade as metal workers in all branches, electro-platers, electricians, electrical engineers, and as workers and dealers in electrical motive power and light. Signatories (with one share each): *J. E. Spencer, M.P., 4, Brick Court, Temple; F. E. Hersee, 144, Leadenhall Street; Arnold Trinder, 47, Cornhill; *A. C. Mitchell, 44, Cannon Street; R. H. Milward, 1, New Square, Lincoln's Inn; H. P. Gordon, Hatton Court, E.C.: W. J. Crozier, New Malden, Surrey. Directing qualification: 50 shares. The first directors are Lord Beaumont, Messrs. J. E. Spencer, A. C. Mitchell, Stephen Thompson, C. W. Torr, F. Simms, and Octavius F. Thompson. The company in general meeting will determine the remuneration of the directors, but it is provided that the minimum amount shall be £5 5s. for every board meeting, and £3 3s. for every committee meeting for each director in attendance at such meetings. Registered 11th inst. by Trinders & Co., 47, Cornhill.

Incandescent Gas Light Company, Limited.—Capital: £500,000 in £5 shares. Objects: To purchase the patent rights of Dr. Carl Auer von Welsbach for incandescent lights; and to manufacture incandescent lights and other apparatus for increasing the illuminating power of gas and other light and heat-producing agencies; also to carry on in all branches the business of electric light and power company, and of a company supplying light by any other means. Signatories (with one share each): Captain M. McTaggart, Catford, Kent; J. A. Kennedy, 81, Graham Road, Dalston; J. K. Trench, C.E., 11, Derwent Grove, S.E.; E. T. Jones, 35, Sydner Road, Dalston; F. H. Smiles, C.E., 33, Stansfield Road, Brixton; W. J. Cameron (engineer), 81, Hatcham Park Road; J. A. Gibbs, 29, The Avenue, Bruce Grove, N. Directing qualification: 100 shares, or their equivalent in stock. The signatories are to appoint the first directors. The remuneration of the board will be at the rate of £500 per annum for the chairman, and £250 per annum for each other director. Registered 14th inst. by Francis and Johnson, 5, Austin Friars.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Electrified Rooms Company, Limited.—An agreement dated 27th ult., provides for the purchase of the patent rights of Captain Arthur Hervey Byng for "Novel forms of applying electricity for therapeutic purposes," and for "A regulator for high tension electric currents," and also for the purchase of certain electrical appliances and instruments. The purchase consideration is £50 cash and seven fully paid shares of £25 each.

Jarman Electrical Company, Limited (in liquidation).—At a general meeting of this company held on the 1st inst., an account was laid before the shareholders showing the manner in which the winding up of the company has been conducted and its property disposed of.

International News Association, Limited. — The registered office of this company is situate at Suffolk House, Laurence Pountney Hill, E.C.

CITY NOTES, REPORTS, MEETINGS, &c.

The Anglo-American Brush Electric Light Corporation.

THE directors' report for the year ended 31st December, 1886, states that although the prospects of electric lighting are in no way inferior to what they were a year ago, the board cannot refrain from expressing their disappointment that the advance made during the past year has not, for the general and special reasons to be stated, been as great as was expected. It must, however, be borne in mind that there has been depression in most trades, and that in face of general stagnation the rapid advance of a new industry cannot reasonably be looked for. That electric lighting has been prejudicially affected by general trade depres-

sion is evidenced by the fact that all other electric companies and firms in this country have experienced with the corporation the difficulty of creating an effective demand for the electric light, notwithstanding that the desire for the new illuminant is all but universal among those acquainted with the sanitary and economical reasons that urge its adoption.

The corporation have, however, continued during the past year to make steady and real progress in organising and developing their business. This is absolutely essential in face of the keen competition offered by no less than 50 manufacturing and contracting electric light firms in the United Kingdom, and in view also of the heavy demands that will most probably be made upon the resources of the corporation, when, with the alteration of the Electric Lighting Act of 1882, the long-looked for revival of the industry takes place.

The arrangements made last year for the conduct of the important relations of the corporation on the Continent have not altogether proved successful, and the hopes that were entertained as to the expected augmentation of the Continental business have not been realised, owing mainly to the high protective tariffs, and to the keenness of foreign competition, especially in North Germany. The Continent of Europe, however, still offers a wide field for the employment of the resources of the corporation, and agencies have been established in Italy, Spain and Portugal, which, it is hoped, will be the means of valuable business in the future.

Arrangements are also in progress for taking over the business of the International Electric Company (formerly the Anglo-Austrian Brush Electric Light Company) in Austria and Hungary, and of an affiliated concern in Vienna, on exceptionally favourable terms, which provide for by far the major part of the consideration being paid in shares of the corporation, and promise highly satisfactory returns upon the capital invested. The properties taken over include the Brush and Lane-Fox patents, which in Austria and Hungary occupy an exceptionally strong position, the well-established manufacturing business of Messrs. Kremenezky, Mayer & Co., of Vienna, including a valuable stock of plant, and the very important and extensive installation for lighting the town of Temesvar, together with the benefit of the existing contract with the municipality of that town. The purchase will involve the issue of not more than 1,476 fully paid shares to the members of the International Electric Company, being in the proportion of one £5 fully-paid share of the corporation for every twenty £4 paid shares of the International Company. A resolution on the subject will be submitted to the meeting for approval. Permission to register the corporation in Austria and Hungary is under application, and the board have reason to congratulate the proprietary upon the prospect of an early establishment of the corporation in those countries under conditions which justify sanguine expectations.

It is to be regretted that during the past year the corporation has not been free from litigation. It will be remembered that in the last report to the shareholders the directors pointed out the necessity which had arisen for obtaining the recognition by others of the valuable patent rights of the corporation. In relation to a process of manufacture known as compound-winding, most of the leading manufacturers of dynamo-electric machines accepted the licences the corporation declared themselves ready to grant against payment of a royalty, but two or three firms having declined to do this, it became necessary for the interests of the shareholders and in justice to the licencees of the corporation to proceed against the manufacturers who were infringing the patent covering the process in question, and the case is shortly expected to be heard.

The other lawsuits into which the corporation have been unwillingly drawn have arisen out of the judgment given by Mr. Justice Butt in favour of the plaintiffs, in the actions for infringement of incandescent lamp patents brought by the Edison and Swan United Electric Company against Messrs. Woodhouse and Rawson; and by the reason of the unwarrantable attack thereupon made on the users of the Victoria lamp, manufactured by the corporation under their patents. In order to maintain their legitimate business in such lamps the corporation had to offer to guarantee their customers against actions that might be brought by the Edison and Swan United Electric Company for alleged infringement of their patents. Proceedings having been instituted by that company against one of the customers of the corporation, the board had no hesitation in giving instructions for the action to be defended in the name of the corporation. At the same time, acting under the highest legal and scientific advice, the board have, with regret, but without any misgiving as to the result, caused an action to be entered against theEdison and Swan Company for infringement of the Lane-Fox patents.

The board have deemed it advisable to enter into an arrangement with Mr. Lane-Fox, by which all his rights in his distribution and incandescent lamp patents become vested solely in the corporation, thereby placing this property on a sound footing as an asset in the books of the corporation. To effect this it has been necessary to liquidate certain charges in respect of which Mr. Lane-Fox had hypothecated these patents. This has been done in one case by a cash payment, and in another by the allotment to the mortgagee of 1,348 fully paid shares of the corporation, and the shareholders are asked to confirm the issue of these shares.

In further pursuance of the policy initiated in 1885, the board have for a small cash payment, re-purchased the Brush and Lane-Fox licenses, for 13 counties in England, formerly held by the Hammond Electric Light Company. By this purchase the corporation have completed the reacquisition of the sole control over the Brush patents in the United Kingdom, save that licenses are still held by local companies at Eastbourne, Hastings, and Dublin.

The Electric Lighting Act Amendment Bill, referred to in the last report as having been drawn up by the committee presided over by the chairman of the corporation, and proposing to place the undertakers of electric lighting on precisely the same footing as the gas companies, both as regards privileges and obligations, was submitted to the House of Lords last spring by Lord Rayleigh, and Lord Bury having also submitted a Bill in amendment of the compulsory purchase clause in the Act of 1882, the Government introduced a third Bill into the House of Lords and proposed that the three Bills should be referred to a Select Committee, which was done; and the committee, presided over by the Earl of Camperdown, took exhaustive evidence for and against the rival Bills. In the end a Bill was agreed to by the committee, though not unanimously, by which the term of compulsory sale to the local authority was extended from 21 to 42 years, and by which the electric companies were placed under some new but still unfavourable conditions. The Bill was practically adopted by the House of Lords, but the Government soon after resigning, nothing further was done last year. This session, however, Lord Thurlow has introduced a Bill, which being based in a large measure upon the evidence taken by the Select Committee, may reasonably be expected to receive ready support in both Houses of Parliament. The Bill proposes to amend the present Act by extending the term of purchase by the local authority to 42 years, and contends for a valuation of the goodwill of an electric lighting undertaking on its compulsory purchase by a local authority in precisely the same manner as other kinds of property are dealt with in similar cases. It proposes also to enact certain provisions with regard to electric lines, which appeared from the evidence given before the Select Committee, to be necessary in the interests of the public.

During the past year important re-organisation has been made of the Engineering Department, and Mr. John S. Raworth has been appointed superintending engineer.

The manufacturing branch of the business has maintained its reputation in face of keen competition, and during the past year the corporation have been engaged in developing various novel applications of electricity to the industrial arts. The use of electricity for motive purposes and as a means of transmitting force to long distances, under conditions which make the use of any other power impossible, has become more frequent, and may now be regarded as an important branch of electrical work. It may also be noted that the Brush Electric Company, of America, have recently constructed the largest dynamo in the world for another distinct application of electricity to industrial purposes, viz., that of the reduction of refractory ores, and the production of aluminium alloys.

To meet the ever changing wants of the industry, the corporation have deemed it advisable to take in hand the re-modelling of some of their types of dynamos, electric light fittings and accessories. In conjunction with the Callender's Bitumen Telegraph and Waterproof Company, Major-General Webber, C.B., R.E., the managing director, has carried out a series of experiments in the laying of electric mains underground, which promise to give highly satisfactory results and to meet one great need in connection with the general distribution of electricity from one centre.

After alluding to the progress which has been made in ship and railway lighting, and alluding to details of the accounts, the directors state that the profit and loss account for the year shows a gross profit of £14,431 0s. 7d. After deducting all standing charges and expenses, which in most cases show appreciable reductions, there remains a balance to credit of the account, including the balance brought forward from last year, of £1,532 0s. 9d., which the directors recommend should be carried forward.

In order to place the corporation in a more advantageous position for carrying out large contracts, and for entering upon such desirable undertakings as may from time to time present themselves, an increase of the available working capital is essential, and a resolution will be submitted to the shareholders for approval empowering the directors to allot at such times and at such premium but not under par as they think fit, not exceeding 10,000 shares of the corporation, on which £3 per share will be called up. The board recommend this course for adoption by the shareholders, in the full conviction that it is not only preferable to the absorption of the present uncalled capital, but that it will serve to greatly strengthen the position of the corporation, with the result of securing to it the increased confidence and patronage of the public and of Governments both at home and abroad.

The Submarine Telegraph Company, Limited.

A MEETING of the proprietors of this company was held at the offices, Throgmorton Avenue, on Tuesday, under the presidency of Sir Julian Goldsmid, Bart., M.P.

Mr. S. M. Clare, the secretary, having read the notice convening the meeting, the following report was taken as read:—

"The accounts for the six months ending December 31st, 1886, show that the receipts have amounted to £70,038 0s. 6½d., and the working expenses to £25,694 13s. 1½d.

"The proportion of the net profits belonging to this company, viz.:—£36,885 14s. 1d., enables the directors to add £8,738 17s. 1d.

to the reserve fund, to recommend a dividend at the rate of 15½ per cent. per annum, carrying over a balance of £190 15s. 10d. to next account. In the corresponding period of 1885, the dividend declared was at the rate of 14½ per cent. per annum, and the balance carried over £414 3s. 0d.

"The average length of the messages in the half-year was 11·11 words against 11·44 in 1885, but 1886 shows an increase in the number of messages over 1885, viz., 200,409 more. This increase accounts for a larger expenditure on stationery, and partly also for the addition to the head of salaries; though a much larger proportion of that addition is due to the further sum now paid to the French Administration for the services of their clerks, and to the usual augmentation in the salaries of the company's clerks.

"The accidents to the cables during the half-year have not been many, and the repairing ship has been a great deal in port. The directors have received a drawback under the policy of insurance for the 12 months ending in August last amounting to £364 10s. 0d. which exceeds by £39 10s. 0d. the half-yearly proportion of the premium paid for insurance of the steamer; and consequently no charge under this head appears in the accounts. The sum of £39 10s. 0d. will be carried to the credit of the insurance account in the next half-year.

"During the half-year considerable repairs have been made to the steamer amounting to £644 5s. 9d. of which £322 2s. 11d. has been charged in the annexed accounts, and the balance will be charged against the revenue of the year 1887. A sum also of £1,253 7s. 11d. has been expended in thoroughly overhauling and repairing the boilers, which has been paid for out of the funds in hand placed to the credit of the renewal of boilers every half-year.

"All the company's cables, as well as those worked by the company, are in good order.

"The Right Honourable Robert Bourke having accepted the important office of Governor of the Presidency of Madras, has resigned his seat at the board of directors of this company."

The Chairman, in moving the adoption of the report, said it would be observed that there had been a considerable increase of traffic. In fact, it was the first time for some period that they had had an increase, and he ascribed it to a great extent to the war scare which had taken place on the Continent, so that that at least had done no harm to this company, and he trusted that in the end others would not suffer so much from it as was now feared. Whether this increase was permanent or not he was not in a position to state. There had been a considerable check to business all over the world for many years. Some people were of opinion that that check had ceased, and that they were come to a time when they would see a great deal of improvement in all business. He trusted that that might be so, and that their business would participate in the general improvement. The reason why the accidents to their cables had not been serious was, he believed, that they had done their best year after year to take care that even the smallest faults should immediately be cut out, so that the cables might be maintained in the best possible condition, and in order that they might be prepared for any eventuality. Regarding complaints which had come to his ears, one of which had been endorsed by a high postal authority in Germany, he said that this company was only responsible for the cables from shore to shore, and the delay which was occasioned to the transmission of messages by the recent snowstorm was in no way attributable to them. In order to be prepared as far as they possibly could, they sent a large portion of their staff down to the coast stations to telegraph from there messages which could not be sent over the land lines from London, and which were conveyed to the coast by train. The Post Office admitted its responsibility, and he wished it to be understood that if it was thought the delay might have been avoided by the use of underground lines, complaint should be made to the Post Office and not to this company. Some people had asserted that the monopoly which this company possessed interfered with the sending of the messages as rapidly as it was possible to send them. All telegraphy was more or less a monopoly. It would be absolutely impossible to have, say a couple of thousand different companies working across the channel. The number of wires to be connected with the English lines was necessarily limited. They had 46 wires, that was 46 different means of communicating with the Continent. On investigation he thought it would be found that, efficient as the Post Office service was, when delays occurred they were owing to the inevitable competition for the use of those wires, and not to any delay caused by the Submarine Company. Under all the circumstances he thought the report of their proceedings for the last half year was satisfactory, and justified congratulations upon the state of their affairs.

The Hon. Ashley Ponsonby seconded the motion for the adoption of the report.

Mr. Robinson enquired as to the expiry of the concession, and whether any negotiations had been made for its renewal.

Mr. Dolman thought it would be premature to discuss the matter now, and not conducive to their interests.

The Chairman said the concession would expire on January 12th, 1889, and he had nothing definite to report with regard to its renewal. Mr. Raikes, the Postmaster-General, had stated in Parliament that the matter was occupying his serious attention, and M. Granet, the Minister of Posts and Telegraphs in France, had in a recent speech stated that he was well aware of the importance of the matter, and should carefully consider it before coming to any conclusion.

The motion was put to the meeting and carried unanimously.

The Chairman then moved the payment of a dividend for the half year which ended December 31st, 1886, at the rate of 15¼ per cent., less income tax, and in doing so said the public ought to remember that the share taken by the Submarine Telegraph Company for the work it did, though it gave a good return now, was a very small portion of the total charge of 25 centimes per word. They took something like 6 centimes, the remaining 19 going to the two Governments.

Mr. Soden seconded the motion, which was agreed to.

A vote of thanks to the directors then terminated the proceedings.

Standard Electric Light and Power Company, Limited.—Resolutions having been passed for the voluntary winding-up of this company, Mr. Justice Chitty on Saturday made an order for the continuation of the winding-up under the supervision of the Court.

Lancashire and Cheshire Telephonic Exchange Company, Limited. — The directors have decided to declare an interim dividend for the half year at the rate of 7 per cent. per annum.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending February 11th were £3,043 after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts for the week ended February 11th amounted to £3,738.

PROCEEDINGS OF SOCIETIES.

The Society of Telegraph-Engineers and Electricians.

AN ordinary general meeting of this Society was held at the Institution of Civil Engineers, on Thursday evening, February 10th, Sir CHARLES T. BRIGHT, M.I.C.E., President, in the chair.

After the minutes of the previous meeting had been read, the names of new candidates announced, and donations to the library acknowledged, the PRESIDENT announced that Prof. W. E. Ayrton, F.R.S., had been elected by a ballot of the Council to succeed the late Colonel Sir Francis Bolton as a Vice-President, and that Prof. A. W. Rücker, M.A., F.R.S., had been elected to succeed Prof. Ayrton as a member of the Council.

Sir CHARLES BRIGHT remarked that it was his sad and mournful duty to refer to the death of their highly valued and distinguished Past President, Colonel Sir J. U. Bateman-Champain, R.E., K.C.M.G., which took place on Tuesday, February 1st, at San Remo. As President of the Society during the International Telegraph Conference held in London, in 1879, Colonel Champain rendered great service to the Society, and all who knew him would remember his always showing the kindness and geniality of a friend. He was one of the most gallant officers of the distinguished branch of the service to which he belonged. He entered the Bengal Engineers in 1853, and served through the Indian Mutiny, and became very soon known as a person of high consideration. He served in and was wounded during the siege of Delhi, and also served at Agra, Lucknow and Cawnpore with such distinction as to be specially thanked twice in General Orders by Sir Robert Napier. He was a man who understood the word duty and did his duty well. With Colonel Patrick Stewart, his then chief, and Sir Charles Bright, Colonel Champain took part in the survey of the Indian Government Telegraph through Persia, in 1863, and succeeded Sir Frederick Goldsmid as Director-General of the Indo-European Government Telegraphs in 1873, which post he held until the time of his death. Sir Charles Bright moved a resolution "That the Society of Telegraph Engineers and Electricians desire hereby to record their profound regret at the decease of Colonel Sir J. U. Bateman-Champain, R.E., K.C.M.G., their distinguished and much esteemed member and past-president, and they further desire to offer Lady Champain the expression of their deep sympathy."

Major-General WEBBER, R.E., C.B., seconded the proposal. He said that few would remember Colonel Champain without great affection. He recalled to the memory of the meeting the modesty with which he disclaimed all personal claim to the honour which had been conferred on him on the night of his inaugural address as president. Throughout his life Colonel Champain showed a modesty which was only equalled by his bravery, and the respect which he left behind him extended far beyond the shores of the mother country. The motion was carried with acclamation.

The adjourned discussion on Prof. SILVANUS THOMPSON'S paper on "Telephonic Investigations" was resumed.

Mr. W. H. PREECE said that on the last occasion he was unable, from want of time, to bring forward certain experiments in support of his contention that the way to improve long distance telephonic working was not by looking to the apparatus, but by regarding the wire. The law that determined the transmission of currents through a wire to produce telephonic signals was precisely the same in every respect as the law that determined the flow of currents through submarine cables, or through any circuit. He

had assisted Mr. Latimer Clark to carry out experiments upon which that law was based as early as 1853, and Prof. Faraday also related the same experiments in his Researches. Sir William Thomson made those experiments the basis of the mathematical law which he produced before the Royal Society, and published in 1855, when he pointed out that the current going out at the end of a cable could be represented by a curve. If time were represented by the abscissa, and the intensity or strength of the current by the ordinates, then the current being applied at the sending end of a cable, after a certain time, a, it would appear and gradually rise until it after some time assumed a maximum, and if the abscissa were divided into intervals in terms of a, then at any period the falling current could be shown by a reverse curve. The whole law depended upon a, which was given by an equation containing a constant which depended principally upon the units used, by K, which was the capacity per unit length (per knot) of cable, by R, which was the resistance per knot, and by the square of the length of the cable. Sir William Thomson's law was as true as Ohm's law, and lay at the root of the basis of the development of submarine cables; it had been proved to be true by Fleeming Jenkin not only to submarine lines, but to all circuits. Cromwell Varley had proved it by his wave bisector, and, in fact, the law which determined the number of currents that could be passed through a wire in a given time, was as absolutely exact and true as any other electrical law. The number of currents that could pass through a wire was not in any way dependent upon the electromotive force starting the current, nor in any shape or form dependent upon the strength of that current, and it was absolutely impossible, on the basis of that law, by any alteration in the transmitter to get a greater number of signals through a long line. By the Delany multiplex system a convenient means was given of cutting up a current into any number of intervals of time, and of measuring with startling accuracy the rate of flow of a current through a circuit, and it was remarkable how exactly the rate at which the current flowed gave the distance to which telephonic speaking was practicable. He had made many experiments in that direction on numerous lines throughout the country, including a cable across the Irish Channel. Given the total capacity, K, of a circuit, which was found by multiplying the unit capacity per knot by the length of line, and the total resistance, R, found in a similar way, K × R, would represent the rate of flow, and, worked out on experiments made, the results were that, when the speed of the current was ·004 to ·003 of a second speaking was barely possible; with ·003 to ·002 it was fair; with ·002 to ·001 it was good; and below ·001 speaking was very good. With lines of various conductors it was shown that the comparative values were with iron 10,000, cables 12,000, and copper, open, 15,000. The difference between iron and copper was due to the self-induction of the iron; the difference between cable and open copper wire was due to the difference in insulation; the static discharge on open lines being facilitated at the insulator supports. It was possible to work telephones underground with freedom from interruption and with greater accuracy, to as great distances as with open iron wires. Much interest had recently been created by the fact that telephonic conversation had been carried on between Brussels and Paris. The line used was No. 4 gauge copper having a resistance of 1 ohm per mile, or for the total distance of 200 miles (or so) 200 ohms; and if the capacity of that wire was equal to the wire used in England, the law would show that speaking was possible for 1,100 miles. The law made it easy to calculate the distance of practical speech upon any circuit. Actual experiments upon an artificial cable used for duplexing the Direct United States cable showed that speech could be conducted on it for 100 miles, while the law gave the figure of practicability at 96 miles, which proved how accurate it was. It was difficult to arrive at any conclusion as to what were the real number of vibrations of the human voice. The dominant note of most speakers was near the middle C, or 256 vibrations per second, but sibilant sounds reached several thousand vibrations per second. He had adopted an average of 1,500 vibrations per second. In actual telegraphic working, the Wheatstone instruments used on an open copper wire line, London to Ireland, transmitted 428 words a minute which represented 193 reversals or 386 currents per second. The limit of speaking, or working distance, was solely and simply a question of the circuit, and had nothing to do with the apparatus. He had used the early Bell transmitter, and a recently introduced transmitter by Berliner, of Hanover, capable of sending very powerful currents without being able to vary the rate of speaking one iota. As to disturbances on the line. What was wanted was to make speech practical for distances of 30 or 40 miles or so, which was not possible at present, at all generally. Prof. S. Thompson argued that by making the transmitter strong and the receiver weak, the disturbances due to various causes would be ground down. Disturbances varied with the distance separating the wires, with the number of the wires on the same poles, with the length of wire forming the primary, and that of the secondary wire, and with the length of the circuit. Short lines were worse than long ones, because the disturbances due to the rate of rise and fall of the primary current would be more rapid on short lines and cause greater disturbances than on long ones. The suggestion made by Prof. S. Thompson had been adopted since the early days of telephony; it was communicated in a paper read by him (Mr. Preece) before the British Association in 1877, it was the basis of the work and discoveries of Edison, and had been used by Mr. Fletcher, the telegraph engineer of the North Western Railway, for short circuits between signal cabins for overcoming the disturbance due to induction from neighbouring wires. But such arrangements were of no avail when contiguous wires were worked by Wheatstone or Delany apparatus. The induction caused by the powerful currents transmitted by Wheatstone and Delany instruments was strong and measurable, it was sometimes about ·014 milli-ampére, which was many thousand times greater than the current used to work a telephone transmitter. He agreed that if it were possible to diminish the sensitiveness of telephone receivers to any large extent it should be done, but it was only possible to a very small extent, and then the limit of the human ear was soon reached. He intended his criticism on Professor Thompson's paper to be in a good spirit and to point out what he believed to be errors of fact and not errors of judgment. He was perfectly ready to admit, notwithstanding all the hard words he had said, that the paper was one which reflected great credit upon the energy of Prof. Silvanus Thompson, although he would not say that he thought it would enhance his reputation very much.

Prof. D. E. HUGHES said that Prof. S. Thompson had in his paper brought forward a series of most interesting experiments, which offered a wide field for discussion. He could not agree in the general classification of transmitters and receivers adopted by Prof. Thompson, who had not, further, sufficiently indicated between those which were merely of scientific interest compared to those which gave results of high value and possessing practical importance. The electric transmission of speech was at first considered impossible, but since the advances made between 1862 and 1878, innumerable researches had shown that almost all changes in matter caused by vibrations, including the effects of heat and light, could be used as transmitters and receivers. He congratulated Prof. Thompson on the new effect he had produced caused by a drop of water between metallic surfaces, for though the effect must be excessively feeble and of no practical value it was an effect most interesting from a scientific point of view. The list of materials mentioned by Prof. Thompson as being those with which he had experimented for microphonic contacts was more extensive than he (Prof. Hughes) had been able to try, and he hoped that the copper selenium composition, mentioned as being superior to carbon for a short time, could be perfected and rendered durable for practical use. The best arrangements of the microphones, whether in single, parallel or series, he believed entirely depended upon the use for which they were required. In his experiments, shown before the Society in the period October, 1877, to May, 1878, he had used carbons in series and in parallel, and he saw then that no new law was to be demonstrated by the method of joining up the microphones, which obeyed the well-known law of telegraphy, that to obtain the greatest variation on a line of high resistance they should be arranged in series, just as the cells of a battery were arranged, because in such a case the internal resistance of the cells was far less than the resistance of the line, so with the internal resistance of the loose contacts of microphones in series. But if in telegraphy it was wished to work a short line of low resistance, then the resistance of the battery and electromagnet must be reduced; so with the microphone, for when it was employed on the short thick wire of an induction coil a battery of large surface or low resistance should be used, and the total resistance of the microphones should be reduced by joining them in parallel. Too little attention had been given to the most suitable induction coil, while a great deal of attention had been paid to the best arrangement of microphones. It was evident that each particular transmitter required that the battery and primary wire of the induction coil should be in proportion to the internal resistance of the transmitter. The secondary wire should also be proportional to the resistance of the line upon which it was used, and, from his own researches, it was evident that great progress would be made by improved induction coils for telephonic purposes, as was shown in Prof. S. Thompson's paper. He could not agree with Prof. S. Thompson's theoretical explanation of the Valve telephone, when he considered that the ball or valve did not itself vibrate, but followed or rode upon the vibrations of the air waves. He (Prof. Hughes) agreed that the ball itself did not vibrate to any great extent, but he could not believe that it followed or rode upon the air waves. In his mind the true explanation would be found in the experimental fact that the sonorous aerial vibrations impinged on the sides of the tube, putting the latter into intense mechanical vibrations, which were conveyed to the ball or valve whose loose contact produced the microphonic effect. The tube did not become a diaphragm when so employed, but from its solid nature was from 12 to 14 times a better conductor of sound than the air, and consequently the vibrations were conveyed through a tube, or it might be a solid rod, with greater velocity and force than through the air itself. There was no difference in the mode of propagation of sounds in solids, and if a solid body, no matter of what form or how used, was a legal diaphragm, then the air itself was an English legal diaphragm. To prove that it was not the ball but the tube which vibrated, suppose the tube closed, below the ball, and allowing the air to escape by a side aperture in the tube, it would be found to work more perfectly than before. Or let the ball be taken away and pencil microphones attached to the exterior of the tube, a very perfect transmitter would be obtained of equal power to those disposed on sounding boards. He did not consider Prof. S. Thompson's arrangement of 108 microphones attached to a rod in connection with a diaphragm, a hopeful arrangement. The to and fro motion of a diaphragm was not necessary, and if the microphones were attached all round the interior of the box, which could be simply spoken into, all the desired effects would be obtained. No doubt the hollow tones of the box would also be present in that case, and therefore, suppose the box filled with pure water so as to entirely submerge the microphones, the hollow tone would then in a great measure dis-

appear, and the microphones would seem to work with increased power, as every portion of the fluid being in a state of tremor, would convey to the microphones the vibrations transmitted by the voice to the water and box. The remarkable power of water for carrying sound was well known, and he had tested the fact by experimenting with a microphone in a public bath. The room appeared quite still, but when a microphone was submerged in the bath a perfect uproar of sounds was heard; doors shutting, flowing of water in other rooms, steps, voices—all mixed in one terrific noise. The remarkable power of the microphone to detect the flowing of water or any leakage in water pipes had received a practical application, for it was reported that "At the recent Congress of Gas and Water Engineers at Eisenach in Germany, it was stated that many German water companies had adopted the microphone as part of the regular equipment of their turncocks, in order to enable them to detect the presence and estimate the importance of any leakage. It was said that the presence of a leakage at the rate of only a few drops a minute could be readily detected by that means." That extract entirely agreed with the experiment of the microphone submerged in the bath, and he believed from that and other experiments that there was a field of research open for microphonic transmitters submerged in fluids contained in receptacles of different forms. He agreed with Prof. S. Thompson that it was not the province of an inventor of telephones to cure the lines of their numerous defects, but to construct instruments which would work satisfactorily through the line defects which at present existed. Long or short distance telephony, like telegraphy, did not depend upon the mere distance or resistance of the line; for, in addition, it was necessary to consider the static induction and the self-induction, both of which caused retardation and a flattening out of the extremely rapid waves; further, there was also leakage from wire to wire, and the electro-magnetic or mutual induction of one wire upon another producing induced currents which greatly interfered with those which alone were desired to be received. Those defects could be greatly diminished by the proper construction of lines; but taking those defects as they existed, he did not believe that better results could be arrived at by the use of less sensitive receiving instruments, or, rather, by instruments having greater inertia in their armatures, and consequently less capacity for rapid currents. It was shown by Prof. S. Thompson that a polarised magnet was more sensitive to rapid alterations of currents than a simple soft iron electro-magnet, and that had long been known in telegraphy, for of the innumerable forms of relays that had been tried for rapid telegraphy, hardly any had survived which were not more or less polarised by a permanent magnet. The Siemens and Post Office forms of polarised relay were well known, but the most highly polarised electro-magnet of all was his (Prof. Hughes's) own invention, patented in 1855, still used throughout Europe in his printing telegraph instrument. In that electro-magnet the soft iron cores were simply the prolongation of the poles of a powerful compound permanent magnet, which form he had found advantageous, because it allowed a powerful retaining magnetic force acting on the armature, and also because an electro-magnet, he had found, when highly polarised, was more sensitive to rapid feeble currents than when not polarised. For that reason the permanent magnet was made to polarise the electro-magnet with far greater power than that needed for the mere holding of the armature; in fact, it was so strong, that in practice its retaining effect on the armature had to be reduced by separating it from the poles by a piece of paper. That was known as the Hughes magnet; but there was another magnet which was not quite so well known in England. In 1863, finding it necessary to use a relay which should be equally rapid as the instrument itself, he constructed several relays for the French telegraphic lines in which his polarised magnet was used, acting at a distance upon a soft iron armature, similar to the other relays, the only difference being the replacing of the old soft iron electro-magnets by the one employed in the Hughes instrument; that acted extremely well, and was still in use. Mr. Elsasser had made, in Berlin, an adaptation of the same electro-magnet which had great advantages for subterranean lines. Looking at the most powerful and successful telephone receivers yet made, as in the box form of the Bell, and in the similar arrangement of the Gower-Bell, the polarised magnet used was identically the same as his, which was a proof that his old form of polarised electro-magnet still remained one of the best for purposes where extremely rapid currents were used. To Graham Bell and his associates belonged the credit of having produced the best telephone receiver by a combination for telephonic purposes of an iron diaphragm with a polarised electro-magnet, but he found no credit whatever due to Gower. The greatest difficulty at present encountered on busy telephonic lines was that due to the mutual induction of one line upon another, and that would also be fatal to sensitive telegraph relays if the power did not exist of so adjusting the armature between its contacts that it would not respond to currents less than those intended to be received. In a telephone, however, the diaphragm did not play between any fixed limits, and a very sensitive telephone was influenced not only by the desired currents, but also by extraneous currents. It was not possible to work on a telegraph or telephone line if the induced currents had an equal or greater power than those desired to be received. Very fortunately, as a rule they were far less, and there was then the adjustment of a sensitive telephone, which so far seemed the best obtainable, to reduce its sensitiveness by removing the electro-magnet gradually away from the diaphragm until the induced currents could either no longer be heard, or that their effect was so small as to be hardly appreciable. Unfortunately, in so doing the sensitiveness of the receiver for its own currents was reduced and the sounds received were greatly enfeebled. The same results could be obtained by using coarser or a less quantity of wire in the electro-magnet, using a switch to cut out more or less layers as desired. But neither of those methods, nor any known method, preserved the loud tones produced by the currents desired and rejected those which were not desired, nor did he believe that the question could be solved by constructing telephones of less sensitiveness without any other corresponding advantage. In all rapid relays the armature had to be small and light so as to have as little inertia as possible. Prof. Bell in making the armature of the electro-magnet a thin iron diaphragm, reduced the inertia as far as possible, whilst from its large surface the lines of magnetic force were not confined to any single part. That freedom from inertia allowed the diaphragm to respond to an almost infinite rapidity of currents with a perfect sharpness of definition. It was well known that all telegraph relays would work as telephone receivers by attaching a thread from the armature to a diaphragm of parchment or any suitable material. That was, he believed, first shown by Breguet in 1877, who attached an ordinary string telephone to the armature of an ordinary polarised relay; it was also shown by Mr. W. H. Preece, about the same time, who took out a patent for the method, but one of the earliest, and the most successful attempts in that direction was made in the same year at the Newfoundland submarine cable station, where an ordinary parchment diaphragm was attached by a thread to the coil of a Thomson syphon recorder and, seeing the sensitiveness of the coil, the result, as stated, must have been extremely good. Some very interesting and novel forms of telephone receivers had been brought forward by Prof. S. Thompson, who had no doubt by comparative experiments been able to test their respective merits, but he (Prof. Hughes) could not agree in the belief of Professor Thompson that the lines of a dynamo must be followed in order to improve telephone receivers. Though both instruments were converters of electric energy into mechanical motion, the motion and the object of each was entirely different. One acquired a continuous rotary motion where the inertia of the armature might be neglected, whilst the other required a reciprocating motion of great rapidity through an exceedingly small space, requiring also that the mechanical inertia must be avoided as far as possible. It was rather necessary to follow the lines of known telegraphic applications, and from those it was known that telegraph relays were far more efficient transformers of feeble currents than any dynamo possible. He thoroughly agreed in one point in Prof. Thompson's paper, that was if more perfect working was to be attained through the present defective lines, improvement must be looked for by way of having more powerful transmitted currents, through a better arrangement of microphones and, above all, in the use of a more perfect and suitable induction coil than the form at present used: for then it would be possible to construct or adjust the receiving telephones beyond the range of disturbances, and to receive with perfect clearness, due entirely to the more powerful currents sent by the transmitter. He had already taken up too much time to allow of going into other of the many interesting points in Prof. Thompson's paper, such as the effect of heat on microphonic contacts and his theory of molecular bombardments, points which he would leave to others, and in conclusion he thanked Prof. S. Thompson for having brought before the society a paper so full of interesting experiments, and one so well worthy of discussion.

After a few remarks by Mr. MOYNIHAN,

Mr. A. STROH referred to the effects of heat in microphones, and remarked that Mr. Shelford Bidwell read a paper some few years ago upon microphonic contacts, in the discussion upon which he (Mr. Stroh) had described certain effects which he had observed and some of which he desired to explain more fully. He had arranged a delicate microphone placed under a small microscope, fixed on a small sounding board, upon which a watch was placed as a source of sound, one cell of a battery being used to provide a current, and a telephone receiver being in circuit so as to listen while the action of the microphone was being observed by the eye. He had not the slightest doubt that Prof. Thompson was correct in his statement that heat improved the action of a microphone, but, speaking of the contacts only, he did not think that any great advantage could be obtained by heat artificially supplied to a microphone, because the passing current created as much heat as was necessary for its action. The microphone in his arrangement consisted of a carbon fixed on a board and on it rested another carbon which moved on an axis, and to which a spiral spring was attached, so that pressure could be applied to the point of contact. The axis was vertical, which avoided any pressure of the carbon itself. When the spring was slightly tightened, sufficient to make microphonic contact and to complete the circuit, a burning occurred for a few seconds, during which time the carbons approached towards each other a little; after which the microphone acted as it should. In the first instance a few points only touched, the current in passing those few points would meet with great resistance, and through the heat thereby produced, would burn the points away until the area of contact was enlarged and consequently the resisiance so reduced as to convey the current without further burning. This state of things was the best condition for the transmission of currents in accordance with sound waves. Sometimes it happened that the area of contact became too large, in that case the current passed without creating any, or but a very small amount of heat, and in that condition the microphone would not work. The current itself, in passing, always adjusted the

area of contact in such a way as to create the amount of heat required for the working of the microphone. The action of the microphone, as to what occurred in the space between the carbons when working, had been very well shown by Prof. Thompson, probably a bombardment of the particles went on which tended to separate the carbons. He was led to the belief of the condition as to the amount of area of contact and the amount of heat created, from experiments in which he had substituted platinum contacts for carbon contacts and had placed a very small drop of oil between them; and when a current was passed through it worked as well as the carbon contacts, but there was a great disturbance in the oil when contact was made, particles flew about, air bubbles formed, and sometimes a thin film of smoke arose which showed the presence of heat. There was a difference between the active and passive states of the microphone and their effects should be considered quite separately. When new carbon contacts were used for the first time as a microphone, at the moment of the passing of the current caused by the contact a click would occur, and the loose carbon would be driven away; if the adjusting spring were strong enough to bring the carbon back again the same effect would be repeated, in a similar manner as with the hammer of an electric bell, for some time, and on tightening the spring the clicks become more frequent, until a point would be reached when the frequency of the repulsions would be such as to produce a musical note. At that moment the gap would be lessened so much that it could hardly be seen with a powerful microscope. By further tightening up, the gap would gradually disappear, the pitch of the note would rise with each turn until it suddenly became quiet. That was the transition from the active to the passive state. In a microphone, when properly adjusted, and the area of contact so as to be suitable for the transmission of currents, the condition is such that the step from the passive to the active state would be exceedingly small, and the closer the two conditions were brought together the more sensitive would be the microphone. (That was practically illustrated by the apparatus on the table, and Prof. S. Thompson listened on the telephone receiver and detected the change of quality or *timbre* of the sound of the watch ticking as Mr. Stroh varied the pressure of contact.) The microphone was in a very sensitive condition when in the passive state, and the slightest mechanical disturbance on the sound board would, as it were, throw it over into the active state. When the watch ticked there was only one single touch, and each tick should only consist of a single vibration, but that vibration was sufficient to start the vibration of the loose carbon, and the microphone produced sounds of its own, and he had come to the conclusion that the same thing must naturally take place when sound or speech was transmitted. The microphone was so adjusted that it was always ready to fall into a state of vibration, and the sound waves impinging upon the sound board would disturb that equilibrium and throw it into vibration; but the sound waves governed and controlled the vibrations set up by the microphone itself.

The discussion was then adjourned.

A ballot for new members took place, after which the meeting then adjourned.

Physical Society, January 22nd, 1887.

Prof. MCLEOD, Vice President, in the Chair.

Dr. F. Wormack was elected a member of the society.

The following papers were then read: "The Permanent and Temporary Effects on some of the Physical Properties of Iron produced by Raising the Temperature to 100° C.," by Mr. HERBERT TOMLINSON, B.A. The paper is divided into three sections:—1, Internal Friction of Iron; 2, The Longitudinal and Torsional Elasticities of Iron; and 3, The Velocity of Sound in Iron.

In his experiments on the internal friction of metals, the author uses a vertically suspended wire rigidly clamped at its upper extremity, and having its lower end secured to a horizonal bar of metal, attached to which are two cylinders of equal mass and dimensions, placed at equal distances from the wire. When the system is set in torsional oscillation the amplitude gradually diminishes, due to the internal friction of the metal and the friction of the air. The combined effect is measured by the logarithmic decrement of the oscillations, and the air effect eliminated by Prof. Stokes's formulæ and the author's experimental determination of the viscosity of air. When the deformations are sufficiently small the experiments prove that the logarithmic decrement of air is independent of the amplitude and period of vibration. These results are only true when the wire has been allowed to rest a considerable time after any change has been made in the arrangement, and when there have been a large number of oscillations executed previous to the actual testing.

Reference is made to some experiments by Prof. G. Wiedemann which show that when a wire is subjected to torsional stress it does not recover itself when the stress is gradually reduced to zero, but remains permanently twisted through a small angle (say θ). By reversing the twisting couple there is a permanent set on the other side of the initial position. If the operations be repeated θ diminishes and attains a minimum. The period during which this diminution takes place is called the "accommodation period."

When a wire is in torsional vibration the position of equilibrium is continually shifting to and fro, through twice the above minimum angle, and Wiedemann considers the loss of energy due to this shifting. The author's experiments verify Wiedemann's results, and also show that time and temperature have great effect on the internal friction. By repeatedly heating to 100° C. and slowly cooling an annealed iron wire for six days, the logarithmic decrement due to internal friction was reduced to about $\frac{1}{5}$th its original amount at the same temperature, and when the wire was maintained at 98° C. the decrement was reduced to $\frac{1}{10}$th.

The author considers the permanent diminution produced by heating and cooling to be mainly due to the slow shifting backwards and forwards of the molecules induced by that process.

In the second part of the paper it is shown that the effects of change of temperature on the longitudinal and torsional elasticities of iron and steel are not nearly go great as that produced on the internal friction. Thus by heating annealed iron wire its longitudinal and torsional elasticities are slightly decreased, but on cooling there is a permanent increase in both. Time is also an important element, for a long rest after cooling still *further* increases both elasticities. From the above results it is evident that the volocity of sound in iron and steel must *diminish* with rise of temperature. This was experimentally proved before the meeting. Attention was particularly directed to this fact, because most of the best text books make the opposite and erroneous statement.

ANNUAL GENERAL MEETING, February 12th.

Prof. B. STEWART, F.R.S., President, in the Chair.

IN opening the proceedings the PRESIDENT regretted that in their report the Council have to record the loss of one who took a prominent part on the proceedings of the Society, the late Dr. Guthrie. It was, however, satisfactory to learn that the appeal of the Guthrie Memorial Committee, under the presidency of Prof. Huxley, had been generously responded to.

The Council also learn with regret from Dr. E. Atkinson, that owing to pressure of work he is unable to retain the office of Treasurer to the Society, and desire to express their thanks to him for his past services. Prof Rücker had consented to be nominated for the office thus rendered vacant, and the Council believed that by his election the connection between the Society and the Normal School of Science (which is so desirable) will be maintained.

The report of the Council for the year 1886 was read and received, and the following gentlemen were elected members of the Council for the present year:—*President*, Dr. Balfour Stewart, LL.D., F.R.S. *Vice-Presidents*, Dr. E. Atkinson, Prof. W. E. Ayrton, F.R.S, Shelford Bidwell, M.A., LL.B., F.R.S., Prof. H. McLeod, F.R.S. *Secretaries*, Prof. A. W. Reinold, M.A., F.R.S., Walter Baily, M.A. *Treasurer*, Prof. A. W. Rücker, M.A., F.R.S. *Demonstrator*, E. V. Boys, M.A. *Other Members of Council*, R. H. M. Bosanquet, M.A., W. H. Coffin, Conrad W. Cooke, Prof. G. Forbes, F.R.S.E., Prof. F. Fuller, M.A., Prof. J. Perry, F.R.S., W. N. Shaw, M.A., Prof. S. P. Thompson, D.Sc., C. M. Whipple, B.Sc., C. R. Alder Wright, D.Sc., F.R.S.

The PRESIDENT proposed the following resolution: "That at the end of clause 11 of the Bye-Laws which says 'Every candidate for admission into the Society shall be recommended by not less than three members, to two of which he must be personally known' there be added, 'when a candidate living abroad is a member of a recognised scientific society, such membership may, subject to the approval of the Council, be held equivalent to the personal knowledge aforesaid.'" The resolution was carried subject to confirmation by a special general meeting to be held on February 26th.

A vote of thanks proposed by Prof. AYRTON, and seconded by Prof. MCLEOD, to the Lords of the Committee of Council on Education, for the use of the rooms and apparatus of the Normal School of Science, was passed unanimously.

The Hon. R. ABERCROMBY proposed a vote of thanks to the officers of the past year for their gratuitous services, which was seconded by Prof. PICKERING.

Sir PHILLIP MAGNUS proposed a vote of thanks to the auditors, Col. Festing and Prof. Fuller, which was seconded by Mr. LECKY and passed unanimously.

Mr. J. Brown was elected a member of the society.

Dublin Royal Society, December 15th, 1886.

"THE physical properties of manganese steel," by Prof. W. F. BARRETT. The author pointed out that Mr. J. T. Bottomley had sent a brief note on the feebly-magnetic character of manganese steel to the Aberdeen meeting of the British Association, and had kindly furnished him with a specimen of this steel, and the name of the makers and patentees, Messrs. Hadfield & Co., of Sheffield. The steel contains 12 to 14 per cent. of manganese. Through Messrs. Hadfield, the author had obtained wire drawn from manganese steel, a process that first presented great difficulties, but was ultimately accomplished with ease by heating the steel to whiteness, and quenching in cold water after a reduction through every two sizes had been drawn. Sudden cooling softens this steel; slow cooling hardens it. A No. 19 S.W.G. wire (diameter 0·98 millimetre) was thus obtained of two kinds—hard and soft; the density was 7·808. The *electric conductivity* was found by Prof. Barrett to be very low. The No. 19 wire had a resistance of about an ohm per metre, the exact specific resistance in C.G.S. units being 77,000 for 1 cubic centimetre; ordinary iron is only

9,800, and German silver 21,170 in the same units; so that some use might be made of manganese steel wire for resistance coils in electric lighting. The variation of resistance with temperature is now being examined. The *magnetic character* of this steel was then carefully tested by the author. Mr. Bottomley found the intensity of magnetisation of this steel, after submitting it to the most powerful magnetising force, was 2·55 in C.G.S. units, or the magnetisation per gramme was 0·013 in C.G.S. Ordinary steel gives a number varying from 40 to 90, and even 100, C.G.S. units per gramme. So that, if ordinary steel of average quality be 100,000, manganese steel is 20. This represents the permanent magnetism. Prof. Barrett, by different methods, has determined the susceptibility—that is, the induced magnetisation—in a uniform field. Compared with iron as 100,000, manganese steel was found to be 300. In fact, it is very wonderful, judging by muscular sense, to find no sensible force required to move this steel, even in the most powerful magnetic field that could be obtained. Hence, as the author suggests, the use of manganese steel for the bed plates of dynamos and the plating of iron vessels is obvious. Ships built of such steel would have no sensible deviation of the compass. As excellent castings can be obtained from this steel, it ought to have many applications from its extreme hardness, enormous tenacity, and feebly-magnetic character. Dr. Hopkinson's important memoir on the magnetisation of iron contains a measurement of the magnetic susceptibility of manganese steel, of which Prof. Barrett was unaware until his paper had been written. Though Dr. Hopkinson's method of determination was wholly different, the ratio of the susceptibility of iron to manganese steel which he obtained is fairly accordant with the number obtained by the author, the composition of the specimen being the same in both cases. As regards the *tenacity* of manganese steel, the author had found the hard wire had the extraordinary tenacity of 110 tons per square inch, or 173·5 kilogrammes per square millimetre—a number confirmed by independent tests which the chief engineer of the Irish Great Southern and Western Railway Works had kindly made for Prof. Barrett. The tenacity of ordinary steel wire is from 80 to 100 kilogrammes per square millimetre, the best pianoforte steel wire alone showing a higher tenacity than the manganese steel wire. The soft manganese steel wire had a tenacity of only 48 tons per square inch, with an elongation of nearly 20 per cent. The *modulus of elasticity* was also determined by the author by direct stretching. It was found to be lower than wrought iron, the mean number for the hard manganese wire being 16,800 kilogrammes per square millimetre, the soft manganese wire having a still lower modulus. The modulus for ordinary steel wire is 18,810, and for iron wire 18,610 kilogrammes per square millimetre; so that, though hard manganese steel has an enormous tenacity, it "gives" more than steel under sudden stress, recovering itself, of course, if the limits of elasticity are not passed. Obviously this is a most useful property for many purposes to which the steel may be applied. Further experiments on this interesting material are in progress in the Physical Laboratory of the Royal College of Science.

CORRESPONDENCE.

Incandescent Lamp Leads.

The interesting article which you published on 4th inst. on incandescent lamp leads, by Mr. Carl Hering, contains directions for ascertaining the size of the cables necessary with a given fall in potential.

It is, however, not simple enough for constant use, and I think the following formula, which I have worked out, and used for some time past, in all my estimating, will be found more generally serviceable, as nothing can be simpler, and it gives the answer in parts of a square inch—

Let A be the number of ampères to be carried;
D, the distance in yards out and home from the dynamo to the distributing point;
V, the number of volts to be lost on the circuit.

Then $\frac{A \times D}{V \times 4}$ = sectional area of copper required in ·0000 square inch.

The figure 4, the only constant in the formula is obtained from the resistance of a bar of copper one yard long, which when the copper is pure 100 per cent. is ·000024275, and when about 97 per cent. = ·000025.

If the measurement is made in feet, the constant, 4, becomes 12 with the same result.

Of course no provision is made for safety, the formula simply giving the area of conductor necessary to produce a given loss in volts.

T. O. Callender.

February 15th, 1887.

Sir Charles Bright's Presidential Address.

My attention has been drawn to a letter from Sir Charles Bright in your issue of the 4th, stating that Mr. Varley never was, to his knowledge, engineer to the Electric Telegraph Company. On this matter I prefer to take the evidence of Sir William Thomson to that of Sir Charles. I enclose excerpt of minutes of "Proceedings of the Institute of Civil Engineers," vol. lxxvii., Session 1883-84, for this purpose.

It is not for me to cast any reflection upon what I regard as an unfortunate and unguarded statement of Sir Charles Bright, which is likely to be very misleading until controverted.

I should be much obliged, in justice to my late brother, Cromwell Fleetwood Varley's memory, if you will find space to publish the enclosed excerpt, which will, to some extent, mitigate the effects of an erroneous statement unfortunately set forth by the president of our society.

I have not seen "Manchester's" letter, which has called forth Sir Charles Bright's reply. But since the subject has been thus reopened I put in my claim on behalf of the late Cromwell F. Varley.

Fredk. H. Varley.

February 10th, 1887.

[We do not publish the excerpt to which Mr. Varley refers, as it is far too lengthy. We may state that it appears rather to confirm than to refute the statement of Sir Charles Bright, for it is clear from a perusal of the evidence of Sir William Thomson that Mr. C. F. Varley was not engineer, but electrician, to the Electric and International Telegraph Company.—EDS. ELEC. REV.]

As I am not fond of controversy, I had no intention of taking part in the correspondence which has arisen on the above, but after reading Sir Charles Bright's reply, in which he states my late brother, C. F. Varley, "was never to his knowledge engineer to the Electric Telegraph Company," I feel it my duty to do so.

The chief officer of the late Electric Telegraph Company was both engineer and electrician during the whole time that company existed, if we except a comparatively short period which occurred during part of the time that Mr. Latimer Clark was the chief officer. The first four chief officers in the order of their succession were Hatcher, Edwin Clark, Latimer Clark and C. F. Varley.

After the total failure of the Atlantic cable, with which Sir Charles Bright had been associated, application on the part of the directors of the Atlantic Telegraph Company was made to C. F. Varley, urging him to accept the post of engineer and electrician of the Atlantic Telegraph Company. They wanted him to retire from the service of the Electric Telegraph Company, so as to be able to give up the whole of his time to the Atlantic enterprise. To induce C. F. Varley to do this, they offered to allow him to name his own salary. The directors of the Electric Telegraph Company, not wishing to lose my late brother's services, appointed him electrician, they largely increased his salary, and they also allowed him to accept the post of electrician to the Atlantic Telegraph Company as well.

When Latimer Clark vacated the post of chief engineer, C. F. Varley succeeded him, occupying the engineer's office, assuming the command of the whole of the engineering staff, and becoming the chief officer of the Electric Telegraph Company, but he still retained the title of electrician.

As these facts must be known to Sir Charles Bright, your readers will, I think, agree with me that Sir Charles Bright's statement, although true to the letter, can scarcely be considered to be characterised by that whole truth and candour which might fairly have been expected of him.

Mr. C. F. Varley was responsible for the design of the conducting core and the electrical arrangements generally of the 1865 and 1866 cables, and the apparatus with which these cables were afterwards worked

were the joint inventions of Professor Thomson, C. F. Varley and Fleeming Jenkin.

Many of those who took part in the Atlantic enterprise have passed from us, and the world has proverbially a short memory; but as Sir Charles Bright has opened up the subject I cannot resist the temptation to say a few words. It seems difficult in these days to understand that notwithstanding the then proposed submarine circuit was much longer than any at that time in existence, and would have to be submerged in depths greater than had been previously encountered, the projectors and scientific advisers of the Atlantic Telegraph Company did not consider it necessary to test the cable under water after it had received its protecting sheathing, a precaution which was adopted and considered most essential at that time by the Electric Telegraph Company with their shorter cables laid in shallow water.

This cable was made by two firms, and so little supervision seems to have been exercised, that the wire sheathing of one half of the cable was a left-handed spiral whilst that of the other half was a right-handed one.

There is little doubt from what came to light afterwards, that had the cable been tested under water, faults would have been detected which could have been remedied, and the cable after it had been laid would probably have worked for a considerable time; as it was when the mechanical operation of submergence had been successfully accomplished in 1858 there was only just sufficient vitality for the cable to speak, and a few messages were transmitted through it. Mr. C. F. Varley stated, during the discussion which followed the reading of a paper by myself at the Society of Arts in March, 1859, on the "Practical Bearing of the Theory of Electricity in Submarine Telegraphy," that had it not been for the ingenious and sensitive instrument devised by Professor Thomson, viz., the reflecting galvanometer, "the cable would never have transmitted a single message, and the world would not have had this great experiment to guide them."

The present generation of electrical engineers would also find it difficult to believe that the scientific advisers of the Atlantic Telegraph Company should, after a series of very costly experiments, have arrived at the conclusion that conductors of small sectional area were more suitable for long submarine circuits than conductors of larger sectional area. But the advisers did arrive at this conclusion, and they explained it on the ground that as such conductors exposed a smaller surface less electric force would be necessary to statically charge them, and that signals would consequently be transmitted more rapidly. Not only were these conclusions arrived at by the electrician of the Atlantic Telegraph Company, but at the discussion on Mr. Window's paper, read before the Institution of Civil Engineers in January, 1857 (about six months before the first attempt to submerge the cable), and to which discussion among others who contributed were Faraday, Siemens, Prof. Thomson, Dr. Wildman Whitehouse, Latimer Clark, C. F. Varley, Mr. (now Sir Charles) Bright, and Mr. Crampton, these startling conclusions were not called in question.

Faraday in his remarks stated that "facts stood apart from all theory," and after saying that he would endeavour to avoid all reference to his own theoretical views, he proceeded to give an explanation of how it was that a submarine conductor of small sectional area transmitted electric signals more rapidly than conductors of larger sectional area.

Mr. (afterwards Sir William) Siemens, in the course of his observations stated that he "thought he had discovered means of accelerating the passage of an electric wave through a cable to twice its natural velocity by simply returning the current through a second insulated wire within the cable instead of through the earth," and in the concluding part of his remarks he stated: "In the experiments of Mr. Whitehouse the line wires had been accidentally under precisely similar circumstances to those provided by Mr. Siemens, but, judging from the projected Atlantic cable, it did not appear that the advantages obtained had been appreciated, as otherwise the cable would have been constructed on totally different principles."

Mr. Crampton confined his own remarks chiefly to the mechanical portion of the problem; but he concluded as follows: "He had hoped that more definite opinions would have been expressed on the question of the Atlantic telegraph, and the silence which had been observed might lead to the belief of the proposed plan being generally approved by the profession; this, however, was not the fact. Contingencies should be prepared for, which was not the case with the present cable, and he must record his opinion that the risk incurred was at least imprudent."

I see it is stated in Sir Charles Bright's reply that Mr. F. C. Webb was not on board any ship during his laying of the Atlantic cable, but on referring to the "Minutes of the proceedings of the Civil Engineers," I find in the discussion which followed papers read on February 16th and February 23rd, 1858, by Messrs. Longridge and Brooks and Mr. F. C. Webb, a copy of an official letter to the directors of the Atlantic Telegraph Company which is signed "Charles T. Bright, engineer to the Atlantic Telegraph Company, Samuel C. Canning, assistant engineer, F. C. Webb, assistant engineer, Henry Woodhouse." I find also the late Mr. G. P. Bidder made the following remarks:—"But it was much to be deplored that the whole fate of so great an enterprise" (referring to the attempt to lay the cable in 1857) "got up at so much cost and upon the success of which so much depended remained even for an instant in the care of unscientific hands. Nor did it appear to have been necessary, for he knew there was an experienced member of the scientific staff on board the *Agamemnon* at the time where his services could not then possibly have been required. He considered, therefore, that neither the shareholders nor the public had been done justice to in that undertaking."

I believe I am right in saying that the experienced member of the scientific staff referred to was Mr. Webb, who at that time had had perhaps more practical experience in paying out and picking up submarine cables than any other engineer.

Whilst the discussion just above referred to was proceeding, I myself wrote and submitted to the institution a paper on the "Electrical Qualifications Requisite in Long Submarine Cables." I was informed my paper could not be read that session, and I was advised through the secretary to take part in the discussion then proceeding, which I did. At a subsequent meeting the President publicly informed me the council considered the views I had brought forward so important that, although they could not reopen the subject that session, they had resolved to read my paper in abstract, when an opportunity would occur for anyone who desired to make remarks upon it. I drew up the abstract, which was read at the following meeting. Although the views I had expressed were directly opposed to those held by the Atlantic Telegraph Company, advisers, as well as other electricians, no one broke a lance with me with the exception of Cyrus Field, who made two accusations; the first one was that I was a *young* man, and the second was that I had gone in the face of Faraday.

In the remarks made by me during the discussion, and also in my paper, I pointed out that induction manifested itself in suspended wires as well as in submarine circuits; that in a submarine circuit the conditions for the development of inductive phenomena were much more favourable than in a suspended circuit, but the difference was only one of degree, and the signals were transmitted through both classes of circuits in a precisely similar way, and not differently, as seemed to be supposed. I showed the fallacy of the notion that conductors of small sectional area conducted signals more rapidly than conductors of larger area; that, on the contrary, signals could not be transmitted so rapidly through the smaller conductors, I stated that induction involved insulation, and I pointed out that in an ordinary Leyden jar, to which a sub-

marine circuit had been likened, the insulation was the resistance of glass, whereas the insulation of a submarine circuit, regarded as a Leyden arrangement, was the resistance of the metallic conductor only which formed the inner coating of the Leyden jar and was always in direct contact with earth (the outer coating); that were it possible to obtain a conductor which opposed no resistance, as there would then be no insulation, there could not possibly be any statical charge, and signals would be transmitted instantly. That when the sectional area of a submarine circuit was increased it resistance decreased as the square of the diameter, while the inductive surface increased in regular proportionals (assuming the insulating material to be of the same thickness), and, therefore, a conductor of twice the diameter would transmit signals twice as rapidly.

As there was no discussion on my paper of 1858, I reopened the matter by reading a paper before the Society of Arts in the following year, in which I entered more fully into the subject, and demonstrated, among other things, that the returning the current through a second insulated wire in the cable instead of the earth as suggested by Siemens, would greatly retard the rate of signalling instead of increasing it. I also described an artificial submarine circuit, with which I proposed to determine the rate of signalling by direct experiment, and which I had hoped to have completed before reading the paper. I also called attention to what is now known as electrification, which I said might be regarded as an approach to conduction, and which would have to be considered in long submarine circuits and required investigation. Dr. Siemens, although he opposed my views on that occasion, when entrusted shortly afterwards with the design of the submarine conductor originally proposed to be laid between Falmouth and Gibraltar, constructed it on the lines laid down by me, and personally informed me he had done so. Before reading my paper of 1859 (the views contained in which I regarded as logical consequences of the laws developed by Faraday in his laboratory experiments) I submitted a copy of my 1858 paper to Faraday who, in the kindest and most complimentary way, endorsed my conclusions.

I am aware I lay myself open to the charge of egotism in referring at such length to my own work, but I think I shall not be very severely criticised for feeling a certain amount of satisfaction at having been permitted to contribute in some sort to the solution of what was 30 years ago the greatest electrical problem of the day.

I received little or no assistance, and had only my private resources and the power to work and to think to fall back upon.

I was rewarded by no professional advancement whatever as a consequence of the hard mental and physical strain which the construction of new apparatus and the verification by actual experiments of the views which I advanced entailed.

It is true my papers received attention at the time they were written, and my 1859 paper was reproduced and favourably commented upon in most of the scientific journals of the day; they contributed also in some degree to my elder brother, the late Mr. C. F. Varley, being applied to by the directors of the Atlantic Telegraph Company to help them out of their difficulties, and this was the first great step that led to his rapid promotion to the top of the electrical profession; but a few years later the papers I had written, and the artificial submarine line which I had suggested and designed, were attributed to C. F. Varley; and when he was at the zenith of his fame, I am sorry to add, he patented my artificial line as an invention of his own.

S. Alfred Varley.

February 12th, 1887.

Secondary Generator Litigation.

We read in the issue of 4th inst. of your esteemed journal a short notice headed "Secondary Generator Litigation," the contents of which are in direct contradiction to the true facts, and, apparently, calculated for the mystification of the public, and especially of those who are interested in the Zipernowsky-Déri system of distributing electricity. We therefore beg leave to rectify the communications of your correspondent by the following explanations.

Last year we brought an action for infringement of the Zipernowsky-Déri patents against the contractors of the central lighting station at Tours, where Gaulard apparatus have been installed in connection with some features patented by Messrs. Zipernowsky and Déri. After having obtained from the local authorities the *saisie déscriptive* of the infringement the case was brought by us before the Court at Tours, but the defendants had asked the Court that *in consideration of the plaintiffs being foreigners* they should be bound to deposit a sum of 300,000 francs as a caution *judicatum solvi*. *This case—and not the law suit in merito*—was pleaded at Tours on July 6th, 1885, and in giving judgment the Court reduced the asked caution to 50,000 francs. Against this judgment notice of appeal was given by the representative of Messrs. Zipernowsky and Déri, and so the case was carried before the Court of Appeal in Orleans, by the judgment of which the caution *judicatum solvi* to be deposited by us as the holders of the Zipernowsky-Déri patents was again reduced to 30,000 francs. Thus the judgment at Tours, as well as in Orleans, was rather in favour of Zipernowsky-Déri. We beg to enclose a legalised copy of the judgment delivered at Tours, which please to return after having taken notice of its contents.

Having thus described the real state of things with regard to the affair in question, we regret very much that there should be persons who—for reasons which we prefer not to discuss, but which are easily detected—do not refrain from mystifying the readers of a scientific journal.

We request you to publish this letter in your esteemed journal, and at the same time we request the editors of such other journals as may have also published the communication in question to take notice of the contents of this letter.

Gauz & Co.

February 8th, 1887.

[We are pleased to insert the above explanation of a matter to which we shall probably refer again.—EDS. ELEC. REV.]

Secondary Batteries.

It is difficult for an inventor, or for those interested in his invention, to answer statements such as those contained in the letter of Mr. Hibbert (December 3rd last year), and in that of Mrs. Tribe in your last issue. I think that it would not be in good form to leave them entirely unnoticed; but, as I never contradict a lady, what can I say (beyond congratulations) in reply to Mrs. Tribe's allegations against the "Union" Company? Is it permissible to suggest that there may be a difference of opinion as to whether they are "undoubtedly infringing?" No doubt, *c'est permis*, so far; but anything like a gratuitous depreciation of the work of Alfred Tribe on my part would, of course, be in very questionable taste. I may, however, be allowed to state, by way of explanation, that although I have often endeavoured to construct negative plates with peroxide of lead "formed from compounds of lead by means of any well-known electro-chemical action or by chemical means," I have invariably failed to obtain any encouraging result in this direction. *Lithanode* is produced from the monoxide, not from the peroxide, of lead.

Desmond G. FitzGerald.

A Workman's Opinion on the Incandescent Lamp Case.

Having had a good deal of experience in the manufacture of lamps of various kinds as made in the works of several electrical manufacturing firms, partly in England but principally in the United States of America, I have naturally read with much interest the various letters and comments on the above subject which have appeared from the pens of Mr. J. Swinburne,

Mr. Le Fevre and others, since the late trial of the case, *Edison and Swan v. Woodhouse and Rawson*, all of whom deserve the best thanks for their attempts to frustrate a monopoly in the incandescent lamp trade.

But to endeavour to upset Mr. Edison's patents, to my mind, has been a mistake. Edison is clearly entitled to a patent, *such as it is*, and as described. Edison undoubtedly claims a lamp of high resistance, say of 100 to 500 ohms resistance with a carbon filament burning in a vacuum and prepared from bamboo cane, lampblack, &c.

Now, as a workman, I defy Mr. Edison or any of his men to make a carbon filament, or even a carbon conductor of any value from lampblack, especially as described in his specification, that will stand a resistance of 80 ohms; but to talk of any such figures as 100 to 500 is simply preposterous, for it cannot be done, as this stuff would crumble to dust in any process used for carbonisation.

But the question of a filament made from such a material as bamboo cane is another matter altogether, and as a vegetable fibre it is probably one of the best of this class of materials used, although I consider, as a lamp maker, that Mexican fibre, chemically and properly prepared, is a much better material for a carbon filament than even cotton thread or bamboo cane, simply because these materials are much less porous than either of them; consequently a better and more rigid conductor can be produced for lamps made up to certain degrees of resistance, which is important where a lamp of low resistance is required capable of producing a brilliant light.

Now, Edison uses Sawyer-Man's process, well knowing that it is better than his own; therefore, to my mind, an Edison lamp, as now sold, is not an Edison lamp at all according to his specification; how then is it possible to maintain a monopoly for that which does not exist?

Next comes the question of Sawyer-Man's patent, which has been greatly altered upon the original one; but what is this patent? It is simply an improvement upon the Canadian lamp known as the "Woodward," invented by him and one Evans, and largely used in Toronto, to my own knowledge, at least 10 years before Edison's lamp made its appearance.

Now, supposing Woodward's patent was in existence in consequence of the 17 years not having expired. According to the Canadian law at the time before Sawyer-Man or Lodyguine's and Edison's United States patents were applied for, notice of objections according to American patent law would, of course, be given to all three later inventors, and I have no doubt this was done at the stages of their application for patents, as the United States Patent Office officials are very strict upon this point; the question then strikes me that if Woodward's patent was in force he would have to be squared, unless his patent was void prior to the above applications, and his interests fully secured before the American patent of the later inventors above mentioned were granted. If not, Edison or any one else would or could not be legally granted a patent at Washington for an invention of a similar kind of patent, for in all of the three cases "*carbonised carbon conductors*" in clear glass globes were used to produce a light by incandescence.

It is true these earlier lamps were all of low resistance, hence the object of Edison or his patent agent sticking in 100 to 500 ohms resistance; probably this idea was simply inserted by them in order to show some presumed improvement in order to secure a patent of some kind, which is plain according to the vague description of Edison, which was only a fishing one, as Mr. James Swinburne very justly observes in comments upon Edison's first patent.

Now comes the question of resistance and materials used for Edison's conductors (or filaments as he calls them) which were then being made by Sawyer and others. Edison has stated 100 to 500 ohms, and he has secured his patent for this and is clearly entitled to it. He speaks of bamboo cane, which does not appear to have been used, but cotton, wood, and other materials were well known; consequently, to my mind, Mr. Edison is clearly entitled to a patent for what he newly describes, but nothing more, and the law should uphold him for such specified claims which are apparently good matter for a patent; and all lamp makers, whether it be Woodhouse and Rawson or anybody else, who manufacture and supply a lamp containing a filament or carbon conductor made of bamboo cane, lampblack, cotton, wood, or other materials as described and capable of standing a strain of over 100 ohms resistance, should be held to be infringers of his patent rights.

But now comes the question of lamps patented and sold by Woodhouse and Rawson and many other makers who do not use Edison's materials or processes, or even make a lamp up to or over 100 ohms resistance; *these lamps clearly cannot be held as infringements*, and to my mind no judge or judges whether it be in the House of Lords or the Court of Appeal will ever hold a unanimous opinion for such to be the case. A question especially to be decided in face of the loophole left open by Mr. Justice Butt for future discussion on this point not yet decided on appeal.

I have spent hours and hours in looking over the various patents filed in the Patent Office; and it is laughable to find how many of them infringe upon others in various ways, also the materials that have been raked up and methods employed for making filaments. Owing to their utter worthlessness such patents appear to have died a natural death; and singular to say there is no patent, although their names are legion, amongst all the multitude of inventions for incandescent lamps that mentions the question of resistance except the inventions of Edison and Shippey; the latter describes a process for a low resistance lamp, and aptly mentions 50 ohms which is a suitable resistance for a glow lamp of low E.M.F. Mr. Shippey also describes a number of useful designs of opaline and fancy glass bulbs for incandescent lighting, neither of which are alluded to by Mr. Edison in any way whatever in any of his patents.

Then there are patents of Swan, Lane-Fox, Maxim, Gatehouse, Bernstein, Zanni, Crookes, Lorrain, Maxwell and others, besides the Woodhouse and Rawson patents, all of which contain certain points of merit in each case, tending towards improvements in lamps, which patents are all of undoubted value, and free from infringement of Edison's rights; for if neither of these inventors intrude on Edison, by the making lamps of high E.M.F., say between 100 to 500 ohms resistance, they would naturally be free from infringement. Lastly, if anyone can even now discover how to make a lamp of 1,000 ohms resistance, or a good improved lamp with carbon filament burning in gas similar to the early patents described by Woodward and Evans and others, then in such cases either or any of them would be a valid patent and no infringement on Edison's rights; and probably in this age of inventive genius, in course of time, some one will come to the assistance of the electrical engineers by supplying a better and more reliable lamp than that sold by the Edison Company at the present time.

I have no interest whatever in any particular lamp, although I have an opinion as to the best. I am a lover of fair play, and I say give Edison all and every bit of what he is entitled to, but certainly nothing more; and, to follow the same rule as that laid down in the Bell telephone, law suits are out of the question; lamp filaments will not bear such a warping.

The British public require lamps, and there is no law in the face of facts that will ever bind or compel John Bull to use a lamp of high resistance if he requires one of lower E.M.F. better suited to his purpose. To me I may say it matters but little as my wants in lamps are but small, and I simply give my opinion upon the case in common with others interested in the advancement of electrical science and as a lover of justice and an admirer of fair play.

Trusting all will end well for every electrical engineer as well as it may for

"Anglo-American."

[This letter has been kept over for some time pending the two recent judgments.—EDS. ELEC. REV.]